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THIS MONTH'S cover illustration is not a 4th of July display; it is a striking photographic study of what happens during the flash welding of two pieces of steel in the General Electric plant at Schenectady, New York. Two semi-circular pieces of steel are being fused into a magnet frame for a direct current motor. Asbestos curtains restrict the flight of the sparks shooting from the welding machine.

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SCIENTIFIC AMERICAN

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NINETY-SEVENTH YEAR • **ORSON D. MUNN, Editor**

JANUARY • 1941

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OUR Point OF VIEW

HOW DO WE RATE?

"OF COURSE, the Old World's scientists are *miles* better than ours."

To a remarkable extent, considering the inaccuracy of their implications, honest beliefs represented by this sample remark heard in conversation appear still to be held in our land. Oddly enough, an opposite type of belief, typified by the assertion "Aren't our scientists the best there are?" appears to exist with them. Just where, then, do these United States of America stand in science, meaning pure science—physics, chemistry, the biologic sciences, and the like?

Largely, of course, the answer to such questions is a matter of opinion, for there is no exact, perfect way to weigh and assess a scientist or a nation's scientists quantitatively and qualitatively. There is, however, a gage which it is believed most objective persons will accept, and this is the carefully weighed and formulated, combined judgment of the Swedish Royal Academy of Science and Caroline Medical Institute, in selecting scientists for Nobel Prize Awards.

An analysis of the Nobel awards in physics, chemistry, and medicine (including the biological sciences) has recently been made by Professor Harvey C. Brill, of Miami University, Oxford, Ohio. Nobel Prizes have been awarded since 1901. Taking the entire period of years, Germany has won the largest number. The numbers are: Germany 37, Great Britain 21, France and the United States each 15, Holland 9, Sweden and Austria each 6, Switzerland 5, Denmark 4, Italy 3, Canada 2, and Spain 1. Our rating here appears fairly satisfactory.

But, as Professor Brill observes, such ratings do not tell the whole truth, so he works out a rating based on population, giving to each nation what he terms a "percentage attainment" The nations now run as follows: Switzerland 417 percent attainment, Denmark 400, Sweden 300, Germany 185 (less than half as good as Denmark's), Great Britain 175, Austria 120, France 115, Canada 67, Belgium 40, the United States 38, Italy 23, and Spain 13.

Professor Brill next breaks the total figures for 1901 to 1939 into two great groups, the first for the years 1901 to 1930 and the other for the last decade. Taking the early group of years, again the little nations run far ahead of the ticket, Denmark leading with 500 percent attainment, Sweden following with 423, Holland with 400, Switzerland with 300, Germany with 180, Great Britain 167, Canada 87, Austria 81, Belgium 55, Italy 21, the United States 18, and Spain 15. In those early years we did poorly.

Far better are the findings for the most recent decade. Switzerland wins a 465 percent attainment, next comes Holland with 217 percent, then Great Britain with 175, Austria 162, Germany goes down with 135 and the United States goes up with 78; France with 44 and Italy with 22 are below us. Our score of 78, for the years of the last decade, is *more than four times* the 18 we received as an attainment score for the earlier years of the prize awards.

And now, how about quality? Since Nobel Prizes are awarded to individuals and not to nations, it is logical to assume that quality averages approximately the same wherever the prizes are awarded.

In sum, our product, the American pure scientist, has reached standard level in quality, and apparently we are entering on the early stages of mass production in the matter of quantity. Since we already have stood high in inventiveness, railroading, automotive engineering, aviation, telephony, and other aspects of applied science, the signs are auspicious for ultimate high rank in both—especially since, in the past decade or more so many corporations such as Bell Telephone, General Electric, and Westinghouse, have clearly demonstrated their far-sighted and imaginative qualities by going in for pure science wholeheartedly, along with applied science. Even though pure science probably pays big dividends in actual money, and these corporations know it, their attitude in helping lift this nation in pure science is not based wholly on desire for gain.—*A. G. I.*

FLEET GROWTH

ONE day last June, an audience of New Yorkers watched an ungainly, yet enormous and somehow consciously powerful, hull slide down the ways at the New York Navy Yard in Brooklyn. It was the battleship *North Carolina*, far from complete and therefore riding high and cork-like.

More than 15 months, we were told, would be required to complete her and her sister, the *Washington*, which preceded her into the water at another yard. Yet both of these were about 80 percent complete the middle of last November and both are expected to go into service several months ahead of schedule. They will raise our battleship total to 17. (Britain has 14 officially, but has doubtless added five more, secretly, since the war began.) Four more of our battleships, the *Alabama*, *Indiana*, *Massachusetts*, and *South Dakota*, will be launched late in 1941 or early in 1942.

In other categories, American construction goes on apace. In 1940, we completed 13 submarines, each of about 1480 tons, and we will add 11 more in 1941. Destroyers have gone into commission at the rate of one a month, and about 15 more will be completed in 1941. Past the half-way mark in construction is an aircraft carrier, the *Hornet*. Light cruisers to the sum of 10 are on the ways or getting their finishing touches, while 15 submarine chasers and 40 motor torpedo boats should all be completed in 1941.

This powerful group of warships, which does not include any units of the 70 percent increase for our "two-ocean" navy, will be a credit to the nation when all are manned by well-trained sailors. Speed in building our "two-ocean" navy is now necessary, for it will take several years for us to complete that remarkable program. Nevertheless, even now, the United States is much nearer the point where she can merely whisper "beware," and have her voice echo thunderously in the ears of all aggressors who would menace this hemisphere.—*F. D. M.*

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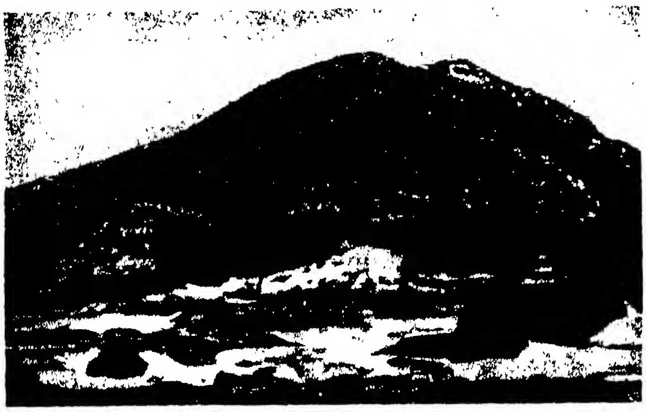
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of January, 1891)

CANAL—The Panama Canal is actually a thing of the past, and Nature in her works will soon obliterate all traces of French energy and money expended on the Isthmus. Reports of October 25 say that the late heavy rains have caused vast slides into the canal from the hilltops near Obispo, and the canal excavation at Circaracha is entirely filled up.

PIKE'S PEAK—The Manitou and Pike's Peak Railway is now a reality. The trial trip over the entire line was made October 20 last, and subsequent operation of passenger trains over a large portion of the road has proved the full success of the undertaking. . . The road is operated by the



Abt cogwheel system. The maximum degree of curvature is 16, or a curve with a radius of 359 feet. The length of the road is a few feet less than nine miles, of which two and three-quarters miles are above timber line. The elevation of the station at Manitou is 6,563.3 feet, the summit of Pike's Peak 14,115.3 feet, the elevation overcome between the points being 7,652 feet.

DEATH VALLEY—Secretary of Agriculture Rusk has been for some time engaged in organizing an expedition to explore the famous Death Valley in Colorado. . . There is reason to believe that there are rich gold and silver mines in the region named. . . The scientific men with the expedition will map the country and procure specimens of such animals and insects as exist there, if any do exist.

POWER—A company is organized for utilizing the enormous water power of Lake Superior and constructing very extensive works in the vicinity of Sault Ste. Marie. The waters of Lake Superior fall at the Sault about 30 feet to the level of Lake Huron, the velocity being recorded by Gen. Powell of the United States service as a little more than 90,000 cubic feet a second. Careful and accurate measurements and calculations show the actual velocity and volume of water to be 122,000 feet per second, equivalent to 236,000 horse power.

TUNNEL—Since our last account . . . about 470 feet have been added to the Hudson River tunnel, which brings the total completed length up to 2,720 feet. This indicates a progress at the rate of about 7 feet per day.

RECLAMATION—Antelope Valley, in San Bernardino and Los Angeles Counties, a high intermountain plain or basin stretching between the Mojave Desert and the upper part of the great Colorado Desert, has been considered, until recently, almost irreclaimable. There are now upon it several great fruit colonies. . . The land now irrigated amounts to 10,000 acres, and will be increased to 25,000 acres. . . This is the beginning of what is believed will result in the reclamation of the whole valley, and even of the Mojave Desert.

NECKTIE—Where will the progress of instantaneous photography end?. . . We have already made known the photographic opera glasses and hat; but now we have something cleverer, and designed to meet with great success among practicians: it is a question of a necktie provided with a pin. The latter is an objective, and the necktie is a camera. When any one approaches you and speaks to you at a distance of 2 or even 3 ft., you press a rubber bulb concealed in your pocket, and you have the portrait of your interlocutor.

STEAMER—On the steamship *City of Paris* there are sixty firemen, who feed the fiery maws of fifty-four furnaces, that create steam in nine steel boilers. Fifty coal passers shovel the fuel from the bunkers to the furnace doors, and the firemen toss it in.

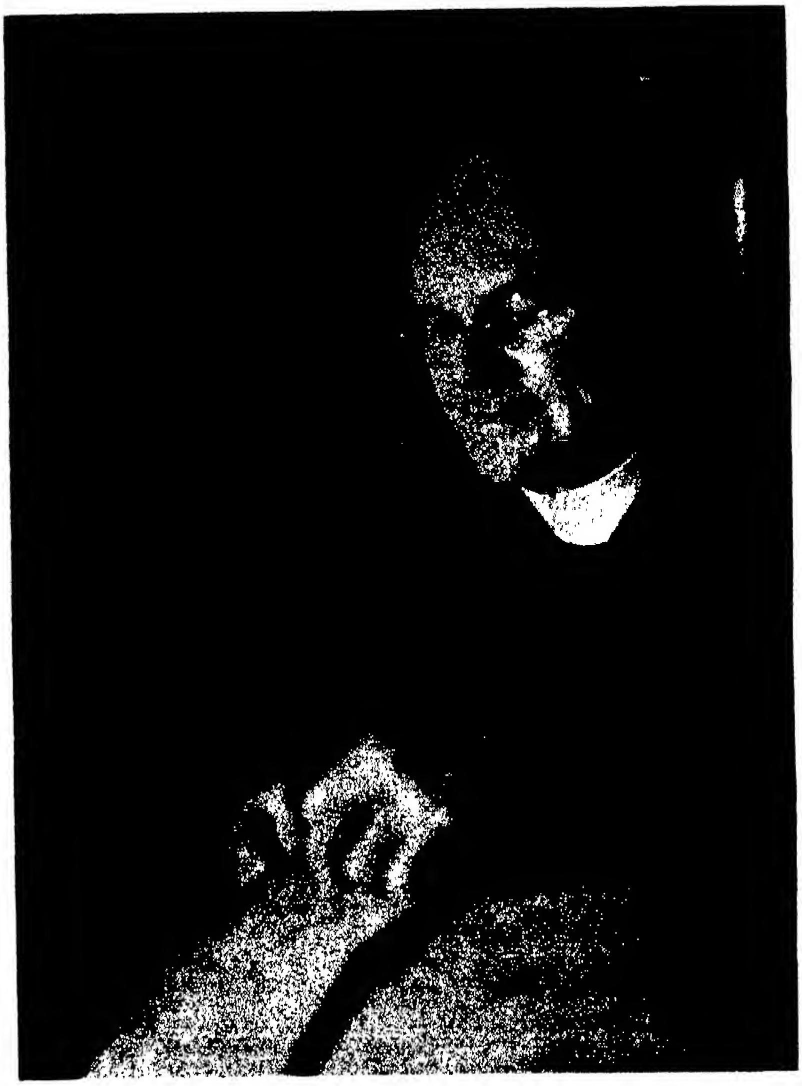
STAR MAPPING—Upon various mountain peaks in the heart of the Andes, from 4,500 to 14,000 feet above the sea, there have been in use for nearly two years past two portable houses, built in Boston in the fall of 1888, and forming the home of a corps of scientists from Harvard University. They are making a map of the southern heavens, after a plan similar to that of mapping the northern heavens, which has been in progress at the university observatory for some years.

SUBMARINE—The French submarine boat *Gymnote* was recently tried at Toulon, and demonstrated its ability to pass through a blockaded line and escape attention in spite of systematic efforts to watch, trace, or discover its course.

CHICAGO FAIR—The last act necessary to start into booming activity the gigantic works pertaining to the great fair has been performed. The presidential proclamation has been issued, and soon we shall see holes in the ground and structures in the air.

CRUISER—On the 22d of December the new U. S. steel cruiser *Newark* had her official trial trip, and proved a great success, the contract requirements being exceeded by about five hundred horse power. . . It is confidently expected that the final figures will show that 9,000 horse power was developed. . . The armament of the *Newark* will be twelve six-inch breech loading rifles; four rapid fire guns, two three-pounders and two one-pounders; four revolving cannon and four Gatling guns. There are also six torpedo launching tubes. Three steel masts are adapted to carry fore and aft sails, and the fore and main mast have military tops.

Personalities In Science



REV. JAMES B. MACELWANE, S. J.

ONE of the most prominent and active personalities among those contributing to the growth of the science of geophysics is Rev. James B. Macelwane, S.J., director of the Department of Geophysics at St. Louis University, St. Louis, Missouri.

He was born in 1883 near Port Clinton, Ohio, and there he spent his boyhood days getting his education and helping his father conduct a fishing business and grow fruit.

In 1903, James Macelwane became a member of the Society of Jesus, and in 1910 he began his studies in seismology, a basic branch of geophysics, at St. Louis University. In 1911 he received his M.A. degree, and in 1923 he received his Ph.D in physics from the University of California.

In 1925 he was called back to St. Louis University to inaugurate its department of geophysics, the first department of its kind to find its way into an institution of learning in this country.

Father Macelwane, as director of the central station of the Jesuit Seismological Association at St. Louis, is at the head of 18 seismological stations located in different parts of the country. By an arrangement with Science Service, data of important earthquakes are telegraphed at once to its offices in Washington, also to the University of St. Louis, from the more important of these stations, from the stations of the United States Coast and Geodetic Survey, and from many other stations in the United States and Canada. This information is interpreted and the location of the epicenter of the earthquake is tentatively determined by the United States Coast and Geodetic Survey in Washington and by the central station in St. Louis. If the two independent determinations agree, the result is immediately released for publication. All these reports, together with many others received by mail, are then published in a preliminary bulletin from St. Louis and sent to more than 350 institutions in all parts of the world. Father Macelwane has worked out a table of travel times for earthquake waves that is now widely used for routine location of earthquake epicenters.

Besides his extensive work as a teacher and organizer in university education, Father Macelwane does a great deal of research in seismology, having made some notable contributions to our knowledge of the paths of elastic waves. Seismology is an exact science which makes use of mathematics to solve the problems connected with the travel of elastic earthquake waves. In his book, "Geodynamics," Father Macelwane has mathematically established the basic principles for interpreting the data of seismological observation. As a result of his research on seismographs he has devised a number of new instruments for special purposes.

He is joint author with Father F. W. Sohon, S. J., of the textbook, "Theoretical Seismology," editor and joint author of Bulletin 90, "Seismology," of the National Research Council, joint author of "Internal Constitution of the Earth," and the author of over 120 published articles on geophysics and other subjects. He is now writing a semi-popular book which he will entitle "Seismology."

Father Macelwane has more than a reading acquaintance with many languages—English, German, Italian, French, Spanish, Latin, and Greek.

Although he is extremely busy in his work of teaching, administration, and research, he faithfully performs his duties as a Catholic priest and member of the Society of Jesus. He is soft spoken, charmingly modest, and lavish with his time to those who seek his advice and direction—qualities that have endeared him to his students and fellow scientists the world over.

THE OUTER MUMMY CASE OF EGYPT'S KING PSUSENNES

THOUGH the war in Egypt finally put a stop to the archeologist's labors there, one enterprising archeologist, Professor Montet, was able, before it interfered with him too greatly, to excavate the recently discovered tomb of King Psusennes, dating roughly 1000 B.C. Nested within two outer and larger sarcophagi was this magnificent one of solid silver, seven feet long, carved and engraved and in almost perfect condition. The discovery is more fully described on page 27, and would have received far more public attention—probably comparable with that given the tomb of Tutenkhamon in 1922—had the world not been preoccupied with current events of vaster moment.

97TH YEAR SCIENTIFIC AMERICAN JANUARY 1941

ANIMAL METHUSELAHS

Which Animals Live the Longest?

BARCLAY MOON NEWMAN

A MAN springs from longevous stock. None surpasses him in ruggedness of constitution. Throughout his life he receives the most expert medical care, which he heeds in regard to both hygiene and diet. He is blessed with health that endures—until he is stricken, lethally, apparently by the mere accumulation of years. His span of life is at an end

When he dies, seemingly of "old age," this man—or any man—could not have lived much longer than a century. All available, trustworthy records indicate that, invariably, even under the most favorable conditions of heredity and environment, a centenarian soon reaches the maximum limit of duration of human life.

The life span of an animal species is the maximum potential longevity —under the most favorable conditions of inherited constitution and of environment. The average length of life of an animal group is the average number of years accumulated at death—no matter how the individuals die, from "old age" or not. Because of the discoveries of medical science, the average length of life of civilized populations has increased a score of years within the century On the other hand, it is claimed that the maximum potential longevity—the life span—has decreased slightly within the past century or two. Thus, there are more older persons, but fewer old gaffers of extreme age.

From observations and experiments on other animals, light is thrown on the factors in the aging of man. How does man's life span compare with the life spans of other animals? What are the striking facts concerning animal longevity? What form is the Methusclah among animals?

Of course, in a sense, certain simple types of animals are immortal, at least potentially so—until accidental death, including disease, strikes them down. For instance, by extensive laboratory studies it has been shown that individuals of some species of one-celled, microscopic animals can maintain their

MEDICAL SCIENCE

vitality undiminished indefinitely, and, in fact, may have remained youthful from time immemorial. How old was the living animalcule model which, under the lens, posed for the drawing of our example Eudorina? There is no way of finding out. Perhaps it was swimming in some forgotten pond millions of years ago.

Here, however, a problem in philosophy is involved. As a general rule, an animalcule does not long maintain its individuality. It may multiply frequently within the day, by dividing itself each time into two separate cells, and continuing to repeat the reproduction, until its personality—if we can use the term—is split into numerous new individuals. In the case of the first division alone, which one of the two new organisms is to be called the original personality? They are twins. It would seem logical to conclude that eventually the original individuality is lost. Immortality of this variety is, from man's viewpoint, unsatisfactory. Such immortality is racial, not individual in the full sense. Man, capable of reproduction, appears to have a similar, racial immortality. Still, in Eudorina, as in man, we do meet with cells that never age; bits of human tissue can be cultured in glassware as long as there are technicians to care for them.

Rejuvenation raises another problem. The slipper-shaped animalcule, Paramecium, may undergo periodic internal reorganization, visible under the lens. The chief change is in the nuclear material, believed to be the main center of control of the little creature's life processes. The nuclear material is present in the form of a large nucleus and a small one. In the reorganization, the larger nucleus breaks up and disappears, while a new large nucleus is produced from substances in the small nucleus. Following this manifestation, which takes place when the animalcule is senescent, there is a striking increase in vitality—a return to youth. But youthfulness is —here at least—demonstrated by reproductiveness. The cell becomes a split personality. Individuality, again, appears lost. And yet, we do see that rejuvenation can occur on earth.

THE intervention of man in the life of these tiny creatures is another interesting consideration. By surgery on a microscopic scale, with delicate needles, an ameba can be operated on at regular intervals. Each time, a minute portion of the shapeless animalcule is amputated. Results indicate that, for some unknown reason, the ameba can thus be kept from growing old. Here, verily, is a successful operation for rejuvenation. Moreover, the ameba does not lose its individuality; the repeated surgery prevents division into new individuals. An ameba, then, with the help of man, is a potential Methu-

selah, and more, becomes deathless.

We must search farther, however, if we are to find the real Methuselah among animals—the creature which does not suffer a splitting of individuality and which has the longest *natural* life span.

Certain sea anemones are believed, upon excellent evidence, to live for more than 50 years; there is a record of one which lived more than 66 years. Some, displaying phenomena like that observed among the animalcules, can undergo a division of the individual, reproducing non-sexually in this way—indefinitely, agelessly; they also reproduce sexually.

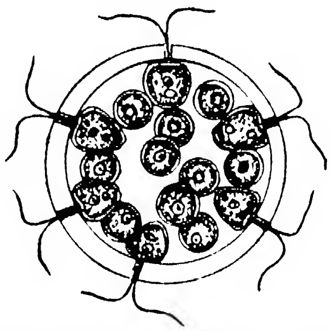
UP ANOTHER rung on the ladder of life, flatworms, with a life span of only a year or slightly more, have representatives which are likewise potentially immortal, and multiply by division, each organism becoming two youngsters. It is even possible to chop a lone flatworm into several pieces, each to become a new whole—just as with the starfish, which oystermen were wont to tear apart because starfish destroy oysters, though fragmenting one serves only to produce several healthy, actively growing young in place of the old one.

As we continue the consideration of cold-blooded, back-boneless animals, we note wide variations in the natural length of life. The earthworm may live ten years, and its cousin, the leech, three times as long. The widespread parasitic worm, trichina, all too frequently sneaking into man from pork not thoroughly cooked, is thought to have a life span as long as that of the leech. Three decades of life is also the maximum which nature has decreed for the crayfish and the lobster. Spiders may live half as long, and other spiders, with a life span of seven years, are only half as fortunate as that.

Especially annoying houseflies appear to live on deathlessly, but the authorities record only a 76-day span. The bumble bee ages to death in a year. As for honey bees, investigation has shown that drones have an existence of a few weeks, workers eight to ten months, and queens six, perhaps seven, years.

The soldiers and workers of the most familiar American termites succumb, presumably because of senescence, within a year or two, whereas worker and female ants are known to live five to as long as fifteen years.

Undoubtedly, the most precise information concerning any insect life span has been built up around fruit flies, which have been bred by the millions for research on the mysteries of heredity. It is frequently stated that a day in the life of the fruit fly corresponds to a year of human life—though this generalization has many exceptions. Further, as in man, in this insect there are short-lived and long-lived stocks, and intermediate spans of life emerge from cross-breeding. Such genetic researches have given rise to deep pessimism, at least in several scientific quarters, regarding the phenomena of aging in man. Length of life seems almost visibly to depend on a secret chemical factor inherited according to fixed laws. For example, there is a stock of fruit flies with small wings; the secret chemical combination producing small wings is handed down generation after generation. The small-wing stock has a short life span. The peculiarity, brief existence, is inherited with, and in the same way as, the other peculiarity, small wings. Similarly, in other stocks, different but equally striking body features are inherited with different durations of life—a specific duration with a specific body feature. These findings, then, are excellent evidence that longevity depends partly on what may be called "inherited constitution." So, at first glance, pessimism about the possibility of extending the natural span of human life would appear justified.



When Eudorina divides in two, each part lives on. Man also divides in two, but the larger part dies, only the smaller living on

Nevertheless, behind the more or less mystical or ignorance-hiding term, "inherited constitution," lie the secret chemical combinations and reactions which make the body or constitution what it is. There are world-famous scientists who now hold unpublicized, informal meetings to discuss the latest advances toward the solution of the problem of the chemical causes behind aging. What one chemical reaction can do, another reaction may oppose or even undo.

The Methuselah of the insects, according to somewhat doubtful evidence, is to be found among the beetles. Many types of beetles die of so-called "natural" causes, or aging, within 7, 11, 15, or 30 years—depending upon the species. But instances are cited of larvae four decades old.

Snails can glide about for a score of years, while their distant relative, the giant clam, is thought to be of the stuff from which centenarians are made. To many fresh-water clams Nature allows a mere ten years or slightly more, while to some species it may grant as many as 150 years.

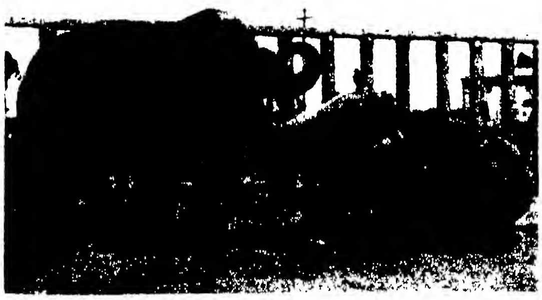
We have climbed to the top branches of the tree of life, whose highest forms are the backboned creatures, the vertebrates, both cold-blooded and warm-blooded. So far, all the forms encountered have been cold-blooded—and the span of life has been seen to vary from hours to more than a century. Cold blood, it follows, does not necessarily mean a long life.

SIZE is not a trustworthy indication of the extent of fated life. Of course, if an animal, such as many a fish, continues to grow throughout its existence, the greater the size, the older the animal is at death. But for a long time it was accepted that, as a general rule among backboned creatures, the bigger the species, the greater its potential longevity. Careful observations have disproved this belief. Potential longevity does not correspond with size. The goldfish may last 30 years, whereas the salmon usually passes on in less than half that period, and herrings within two years. In a year, Goby is no more.

The eel slips through half a century, ending in a dead heat with the carp. The catfish has been clocked at 80 years. Fabulous ages often assigned to the pike do not receive scientific confirmation. William Beebe's bathysphere, however, may someday discover a deep-sea dweller which swam miles beneath Columbus' ship. All discoveries have not yet been made. Conditions down there are nearly the utmost in calm and stability—two of the most publicized factors in realizing one's maximum potential longevity. Many fishes, like a few men, reproduce throughout life.

Amphibians, above the fish in terms of evolution, are below in terms of longevity. Common frogs in six years accumulate changes leading to senility; but it is said that you can come across bullfrogs a full decade older. A Methuselah among amphibians is the giant salamander, which may boast of being a semi-centenarian.

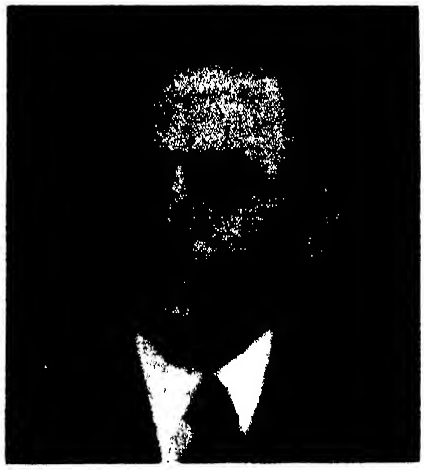
Obviously, reptiles are tough—physiologically so tough that they live a long time. This fact, of course, has given rise to the common belief that all cold-blooded creatures are long-lived. But all invertebrates, as well as fishes and amphibians, are cold-blooded—that is, they have body temperatures which vary with that of their surroundings, whereas birds and mammals maintain a remarkably constant, relatively warm, internal environment for their tissues. Also, many birds outlive many reptiles, and there is great diversity in potential longevity among the reptiles alone. Some lizards can survive only a decade or so, while others have life spans of three or four decades. Every now and then, snakes 30-odd years old are to be met with. Alligators are not as tough as their cousins, the crocodiles, among which semi-centenarians are not rare. Turtles or tortoises, though they do not achieve the years attributed to them by popular fancy, are veritable Methuselahs. Science believes that they can paddle and waddle through seven score to possibly ten score years.


On the basis of indisputable record, the elephant is Methuselah No. 1, though there is unproved suspicion that the whale wins

Our interest waxes as we come to the warm-blooded, the birds and the mammals; for now we are considering constitutions very like our own. Physiologically, the constant maintenance of a comparatively high body-temperature makes possible the existence of life in an entirely new guise. A warm, steady internal environment which does not shift with the winds, means increased freedom of activity, a steadier brain, a more agile brain cell, hence the development of powers of the highest order.

Because of the cramping effects of their peculiar anatomy, especially the lesser development of their nervous system, birds cannot realize the full potentialities of this constant warmth; but, as warm-blooded creatures of a type distinctly different from mammals, they do act as a source of important information about the general price to be paid, in terms of longevity, for the privilege of living in the top branches of life's tree. For example, the students of senescence often assert that a very active person, with a high rate of use of energy, will usually not endure as long as the quieter individual; calmness, they say, is the great aid to attaining maximum length of life. Birds are very active, and what creature is more excitable than a hen? Their body temperature may be ten degrees above that of man, and with small bodies having a more rapid loss of heat than the bulkier form, the rate of use of energy is remarkably high. Yet crows sometimes can outlive elephants and whales—and even many species of turtles. Vultures, too, are frequently stated to be centenarians. Records there are to show that geese as well as some parrots may aspire to three score and ten, and beyond. The ostrich, largest bird, is very lucky if it attains 50 years; per pound, its rate of use of energy is less than in its diminutive though longevous relatives. Hence, it has been suggested that that cloak of ignorance, the term "inherited constitution," obscures factors which by pure coincidence bring about the apparently frequent association of high excitability and low potential longevity.

Thus, a person who is overly excitable and overly active (from the popular viewpoint) may be so only because he has a peculiar combination of chemical factors adding up to a defect, and the same defect may, through an unlucky series of chemical events, bring about a rapid aging; in another man, the dice fall differently and the peculiar chemical combination may be the very means to longevity in this particular case, even with an accompanying over-excitability. Certainly, there are numerous cases on record of extremely longevous men who have made it a life-long habit to burn the candle at both ends. Nature works by devious systems, and the problem is not simple.


Dr. George C. Supplee, of the Borden Research Laboratories, recently discovered a longevity promoting vitamin. Such research is beginning to elucidate the influence of food on aging rate

It is sometimes claimed that the mouse and the elephant must dwell in different worlds of time. The mouse in three years completes what the elephant does not for possibly 80 to 120—the life span. Because of its small size, the mouse loses heat more rapidly and must expend energy at a higher rate to keep a constant body temperature; per pound of bulk, the elephant has a lower energy turnover. Exhibiting this higher physiological activity, the heart of the mouse beats 20 to 30 times as fast as the elephant's. Many scientists have stopped here to speculate instead of going on to experiment and observe more. They tell us that the mouse in its lifetime has somewhat more than a billion heart beats; the elephant in its lifetime, somewhere near the same number. It is implied that our own life spans are dependent upon heart rate.

Recently, Dr. Raymond Pearl, of Johns Hopkins University, a leading authority on aging and mortality statistics, reported that new records concerning more than 2000 dead men ran thus: The short-lived apparently differed from the long-lived in only one characteristic, the heart rate. The average pulse of the short-lived had been above the average man's 72 per minute; the average heart

rate of the long-lived had been below 72. Dr. Pearl and his associate, Dr. W. E. Moffett, tentatively conclude again that, in general, the duration of life depends on the rate of living. At best, this conclusion is merely tentative; so many factors are involved that we do not have any reliable conception of their relative significance.

The white rat, through the agency of Dr. Clive M. McCay and his collaborators in the Animal Nutrition Laboratory at Cornell University, has just increased the intricacy of our already vastly complex problem of senescence. Is the mammalian life span fixed? If not, how can we pick the Methuselah No. 1 among animals? May not some slight adjustment in the environmental conditions force us to give the championship of years to some dark horse? Ten years ago McCay set to work. His results are measureless in their implications. The life span of the white rat—chief source of modern knowledge of human nutrition—has been extended not merely a significant number of months but even so as to correspond to an extension of the human life span to 138 years.

The secret is a slow approach to maturity. Growth is slowed by holding down the number of daily calories; otherwise, the diet is complete. In 10 days, the white rat accomplishes what corresponds to a year in the life of man; in 700 days the creature lives the equivalent of 70 years in human existence. McCay's oldest, retarded rat lived almost 1400 days. The experimenters conclude: "Our data indicate that the retardation of growth affords a method of retarding senescence and extending the span of life far beyond the normal. The method provides an effective technique for attacking the problems of aging within the body of experimental animals. . . . Our philosophy need no longer anchor us to the concept of a fixed life span."

So it is now possible to claim that the belief in a fixed span is baseless and that the potential longevity of any animal is utterly unknown. There is no scientific reason to believe that this discovery could not have been made with the human being instead of the white rat.

An editorial in the *Journal of the American Medical Association* suggests that many so-called normal but pathological conditions almost characteristically found among senescent men and women, such as fragile bones, may really be abnormal, caused by deficiency of certain food factors, possibly including vitamin D. The time may come when all scientists, not just a few, will look upon aging as an unnecessary disease; or it may turn out that pessimism through the millenia has been justified and that the modern Ponce de Leons are in error, there being no fountain of youth nor any elixir of life. We need more facts, countless more, before we can judge.

But what of our search for the Methuselah among animals? On the basis of indisputable records, the elephant, just as is popularly believed, holds the title of Methuselah No. 1 among the mammals, but on the basis of unproved speculation, the largest animal—mammal or not—that ever lived, the whale, wins, with a longevity estimated by certain perhaps imaginative scientists at "several hundred."

Clams, turtles, elephants, whales, and men—these are our Methuselahs among animals. Will man upset all calculations and learn to live on and on, indefinitely? More and more our best scientists are coming to believe in this interesting possibility

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TOO STRONG

Bones Can Be Broken By One's Own Exertion

BROKEN bones due to violent muscular exertion are rare, but six such cases were reported by Dr. Frank P. Strickler, of Louisville, Ky., to the American College of Surgeons, according to *Science Service*.

In each of three of these cases, the muscular violence of pitching a ball broke the bone of the pitcher's arm. A young woman broke the bone in her left arm by forcibly throwing her arm out in an effort to catch herself while falling, although her arm did not hit anything.

A structural steel worker broke his knee cap by muscular violence when he was sitting with his back braced helping to push a steel beam into position with his left leg flexed at the knee.

A young farmer broke several vertebrae in the left side of his back when pushing a truck that had become stuck in a mud hole. He felt something give way in his back and had acute pain. At first he thought he had lumbago, but eventually an X-ray picture of his spine was taken and revealed the broken bones.

All the patients made good recoveries.

SCHIZOPHRENIA

New Operation Improves Chronic Mental Patients

LONG-STANDING cases of schizophrenia, commonest form of insanity, have responded in encouraging manner to a new operation in which fibers of the frontal lobe of the brain are severed. This and other so-called "drastic therapies" were discussed by Dr. Edward A. Strecker, of the University of Pennsylvania School of Medicine, at a recent conference.

The surgical procedure mentioned by Dr. Strecker is known technically as pre-frontal leucotomy, referring to the cutting of white matter in the pre-frontal lobes of the brain. It was devised by Dr. Egas Moniz, of Spain, and was introduced into this country a few years ago by Dr. Walter Freeman and Dr. James W. Watts, of the George Washington University School of Medicine, who have modified the technique. A narrow spatula-shaped instrument is inserted through a hole drilled in the region of the temple and a fan-shaped cut is made in the brain tissue.

The results, he reported, were interesting and sometimes truly amazing. The patients' aggressiveness, in some instances homicidal in degree, disappeared; mental material which one would have believed irretrievably lost was apparently salvaged by the operation and was utilized by the patient in establishing realignments with life; panic reactions due to hallucinosis were terminated. The hallucinosis continued but a recall of the patient to reality in some of the cases was very easy, a few simple questions sufficing. Dr. Strecker said he believed the operation severed the vivid emotional setting of the hallucinations. While the operations did not effect complete cures, "life became bearable and pleasant for patients who before were living in veritable misery."

BROWSING with the Editor

DURABLE SWITCH—The world's first household mercury switch, which has been operated constantly by means of small electric motors turning the lamp on and off for a number of years, finally gave way recently after surviving 220,000,000 flips. This represents many centuries of ordinary household use.—Notes, General Electric Company.

MOVIE REALISM—Bleached cornflakes are gradually losing their job as movie snow, for some whole movie sets are now being refrigerated to insure greater realism. Also, recently one producer of a tropical picture kept the studio at 98 degrees in order to create an authentic heat frenzy among his actors.

REPULSIVE ODOR—The human nose registers rapidly and emphatically a concentration of butyric acid as small as six parts in 100 billion! This acid is a common constituent of "B. O."—*The Industrial Bulletin* of Arthur D. Little, Inc No. 161.

BRITISH TOYS—Though Great Britain is not normally considered the home of the toy-making industry, the largest toy-making factory in the world is situated near London.—*Plastics*, (London), August, 1940.

LONG RUN—The longest regular run of a Pullman car is between San Francisco and New Orleans—a distance of 2492 miles.—Notes, Association of American Railroads.

A FORTRESS, A ROAD—Comparing the Maginot Line with the new Pennsylvania Turnpike: 15,000 men worked on each; the former involved 20,000,000 cubic yards of excavation, the latter 26,000,000; the former used 50,000 tons of steel, the latter 46,500; the former used 2,500,000 cubic yards of concrete, the latter 1,650,000. The Maginot Line took 10 years to build while the Turnpike was built in 20 months.—*Highway Research Abstracts*, November, 1940.

LLAMA FLEECE—All the members of the llama family—the domesticated llama; the wild guanaco; the vicuña, source of the rarest textile fabric; the suri, finest breed of alpaca; and the huarizo, born of llama father and alpaca mother—provide for the world's markets about 5,000,000 pounds of clean, usable fleece a year.—*Oil-Power*, November, 1940.

INSECT IMMIGRANTS—There are still at large in the world some 20,000 kinds or species of insect pests, which have not yet been found in the United States.—Notes, No. 1164, U. S. Department of Agriculture.

GASOLINE—American production of aviation gasoline of all grades has reached a record peak of about 45,000,000 gallons a month, or more than 1,500,000 gallons a day; and the supply has more than doubled in the past year.—Fred Van Covern, American Petroleum Institute.

OIL PRODUCTION—The United States produces two thirds of the world's petroleum, has two thirds of the world's refining capacity, and possesses the largest oil reserves in history.—Notes, The Texas Co.

WAR HORSEPOWER—During World War I it took about 4000 horsepower to run a division, but today it takes 187,000—for tanks, trucks, motorcycles, guns, and cannon.—Advertisement, Pacific Coast Petroleum Industry.

DEATH OF FALSE HOPES—Some years after the chestnut blight swept over the eastern part of the nation, killing all chestnuts, the regrowth of stump and root sprouts gave hope that these represented resistant future trees, but now, after 25 years of record keeping, not a single American chestnut tree has been found that can be regarded as truly immune.—Notes, Bureau of Plant Industry, U. S. Department of Agriculture.

PLUMBING, FIXTURES, ETC.—The total of all uses of steel in house construction and modernization in 1937—the last year for which comprehensive statistics are available—is estimated at 700,000 net tons.—*U. S. Steel News*, October, 1940.

FOOD—Approximately 1100 carloads of foodstuffs are delivered by the railroads in New York City and suburbs every 24 hours, on the average.

HOT AS THE HINGES—For the highest temperature ever recorded, consider Azizia, in Libya, with its one-day record of 136 degrees, Fahrenheit—in the shade! Death Valley, California, still holds the record for consistent, high average heat, which has been as high as 102 degrees for a whole month of July.—Dr. W. Gorczynski, Scripps Institution of Oceanography.

ROADS—There are an estimated 3,619,000 miles of highways in the 21 American Republics, of which over 3,000,000 are within the borders of the United States.—*Ethyl News*, October, 1940.

TURTLE EGGS—Loggerhead turtles deposit thousands of eggs in the warm sands along the Florida coast from May until August. Nests are made at night and the eggs are roughly spherical, the shells calcareous, but soft. It is thought that this species of turtle lays three times during each summer: approximately 150 eggs the first time, fewer the second time, and about 80 the third.—*Natural History*, September, 1940.

OIL VERSUS MUSCLE—It would take 8,000,000 galley slaves to propel the *Queen Mary*.—Arthur H. Compton in *The Rotarian*, October, 1940.

THE PEOPLE'S NATIONAL FORESTS—In 22 years, the number of visitors to the national forests has increased from 3,000,000 to 32,000,000; and this figure promises to double in the next decade.—*Forest Outings*, U. S. Department of Agriculture.

BRAIN DRAIN—Gerald Johnson, interpreting statistical tables compiled by Howard Odum of the University of North Carolina, estimates that the exodus of southerners to the north and west has exceeded 3,500,000; and that to rear, school, and then lose this many men and women to other parts of our country, has cost southerners at least $17,000,000,000.—*Forest Outings*, U. S. Department of Agriculture.

CROSS TIES—The number of cross ties in the average mile of railway track is 2994, with an average spacing of 21.2 inches, center to center.—Notes, Association of American Railroads.

Heroes In Glass Houses

High-Speed Planes and Modern Armament Provide Intricate Problems for Aerial Gunners

JAMES L. H. PECK

If the soothsayer who coined that phrase about stone-throwing had a soft spot in his heart, he might well appreciate the lot of the men who live and die in glass houses in the clouds. The stones they cast are of lead and steel; and in the throwing they trace smoking lines which literally write today's news against flaming skies. Among the bravest of air warriors are the men who ride the "rumble seats" of bombing planes—the aerial gunners.

Hectic 1940 will long be remembered for, among other things, the fiercest air war since the birth of the flying machine. This unpredictable year, 1941, may have also passed before the real air score becomes known; but whatever the tally, the flying gunners, of whom the communiqués seldom speak, have chalked up a goodly portion of the thousands of fallen Axis and Royal Air Force warplanes.

The long-range heavy bombers and medium bombers — smaller types carrying lighter loads of bombs and fuel over shorter distances—being employed for the daring and ruthless raids by belligerents are manned by combat crews consisting of two or more gunners in addition to the pilot, bombardier, navigator, et al. The machine gun or cannon armament with which they fend off enemy back-biters is disposed about the plane in such a manner as to provide defensive firepower against other planes from almost any direction. Certain angles forward, to the rear, and below—points from which assault is most probable—are covered by the fire of one gun and may be supported by the crossfire of one or more of the others. The bomber's mission, essentially, is not one of combat; it must penetrate enemy defense and then score. The gunner's job is to ward off tacklers—in the form of enemy interceptors—and an unglorified job it is

He must sit cramped and alone in the narrow confines of his gadget-filled quarters for hours at a time. He is often cold, having only the shelter of thin plastic or glass walls to protect him from the frigid temperatures of high altitudes. His often-tense body becomes numb from the bomber's vibration; particularly so if his post is in a tail turret, but he must fight off torpidity as he would enemy planes. It is he whose responsibility it is to spot those hostile craft sneaking up from behind or diving down a blinding sun lane. Wherever the station—in nose turret, tail, or fuselage—he remains most exposed to gunfire.

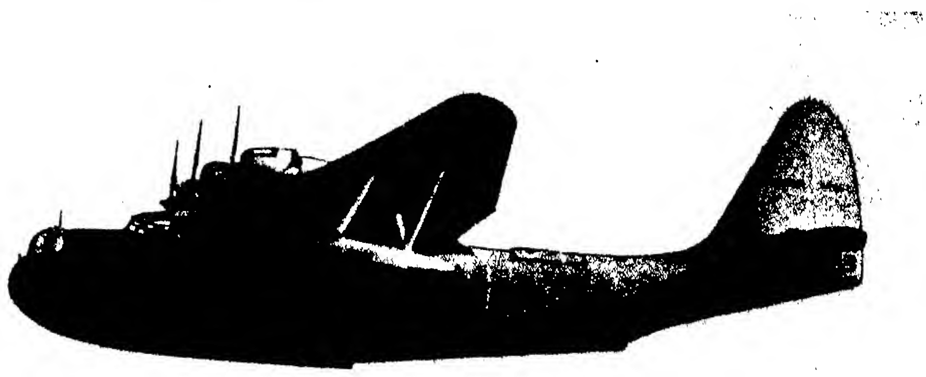
Gunner casualties run as much as three to one higher than those involving pilots. Because of the difficulty of entrance and exit, his chances of being able to escape from the turret of a disabled ship are small indeed: usually he remains a prisoner in his transparent cell until the crash. He is further bound by the most rigid discipline in the use of his guns. There are times when he must withhold fire until he can almost see the proverbial whites of their eyes; and, just so often, the enemy pursuit pilot who ventures that close can also register a vital burst. There are circumstances under which the gunner must sit idle while he is a target for the whole hostile force, staring death in the face literally and figuratively.

Such an unhappy situation might arise during long-distance operations over extensive enemy territory, such as the RAF forays against northern Italian objectives. Should the bomber be intercepted on the way over, the gunners would save ammunition while the pilot made a run for it. They would not commence firing until it became apparent that the ship and mission were gravely endangered. Such restraint, orders or no, is admirable in the face of imminent death. The reason for this is that ammunition must be conserved for the expected combat at or around the objective—once it is attained—and for the running fight on the homeward leg of the flight. When bombers are intercepted early on the outward leg, the crews may well expect a warm reception at their destination and a hot one on the way home.

Bombing-plane gunners use their armament, for the most part, for defensive purposes. This is also true in the cases of the boys who ride the rear seats of dive bombers,

Official photograph, U. S. Navy

Glass nose turrets and side "blisters" house aerial gunners who can defend these Boeing Flying Fortresses from planes attacking at any angle



Official photograph, U. S. Army Air Corps
A Vought-Sikorsky patrol bomber with rotable nose turret and gun emplacement at extreme end of tail. Here hold forth "heroes in glass houses" of this article

torpedo planes, reconnaissance craft, and other multi-seaters. But the fellows who ride back there in the new two-place fighters are back-seat drivers, literally. Their ascendency to World War II authority—only in a tactical sense, as most gunners are low-ranking enlisted men—was a hard-won climb by trial and error.

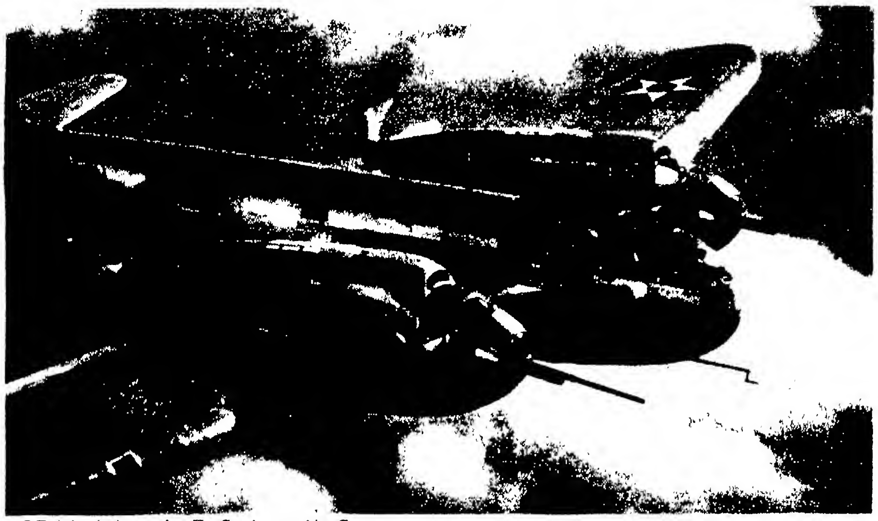
During the early days of World War I, enemy airmen waved greetings at one another as their ships passed in the air. Becoming more belligerent, they resorted to taking pot shots at each other. From this the military took its cue, and the pursuit or "chaser" plane came into being with the development of fixed machine guns that could be synchronized to shoot between the whirling propeller blades. In combat, the pilot aimed and flew his plane straight at the target—which is the current procedure for single-seater fighters—and the guns were actuated by a cable-control device with the triggers, or "trips," mounted handily on the ship's control stick. Then an additional gun was mounted flexibly on the top wing. When two-seater craft were used, this extra gun was installed on a universal-jointed Scarf ring atop the rear cockpit and a "full-time" gunner went along to keep the pilot company. Thus the combat team was born. The man in the front seat did practically all the fighting, and the rear gun barked only when the enemy happened to attack from within its sphere.

A few of the more enterprising combatants entered into the spirit of co-operation. In a sky scrap, after the pilot had done his best with the fixed, forward-firing guns, he maneuvered the plane to give the gunner a play. From then on, teamwork was the watchword. But the man behind that back-seat gun was even more exposed than today's gunners. It was a common occurrence for the pilot to land safely enough, only to turn and see his teammate slumped in a gory seat, draped grotesquely over the cockpit's side, or missing altogether. When the gunner remained unscathed, he was often slumped in his seat anyhow from the sheer fatigue of swinging the heavy armament against the terrific blast of the propeller slipstream. Today, the rotating, power-driven turret swings the guns and also protects the flying artilleryman from a slipstream which may amount to more than 400 miles per hour in combat planes.

Typical of World War II back-seat drivers are those aloft in Britain's two-place fighter, the Boulton-Paul *Defiant*. Here the gunner is ship's captain, and the pilot has only sufficient forward-firing armament to meet a head-on assault; he maneuvers the plane in accordance with the captain-gunner's instructions. Such orders are usually to swing alongside the enemy so that the gunner may deliver a shattering broadside with his multi-gun turret Just as his tools have been improved through the years, the aerial gunner's trade has become a science; and the ever-increasing performance of fighters and bombers has introduced additional ballistic considerations which give the gunner headaches aplenty.

The most painful of these have to do with "deflection," or off-aim. Hunters and skeet shooters "lead," or aim ahead of their targets, but their guns are fired from a stationary rest, comparatively speaking. Aerial huntsmen have to bag 400-mile-per-hour pursuits and 250- to 300-mile bombers from ships traveling at comparable speeds, hitting a moving target from a moving station. A gunner firing from a plane in a side-slip, for example, must allow for the fact that his weapons are traveling through *three directions* simultaneously; the slipping ship is moving forward, sidewise, and downward. Roughly speaking, if he were shooting at a plane just 100 yards away—providing that his plane and the enemy's were both flying at a constant speed of 240 miles per hour on 90-degree, perpendicular courses—the gunner would shoot 72 feet ahead of the crossing enemy plane. Speed in combat is rarely constant, however. To facilitate aim, reflector sights—which swing off center to compensate for the effect of the slipstream when the guns are fired at an angle to the planes' paths—are employed, but these only approximate the effect of windage and do not account for the enemy's speed. For head-on shooting with the fixed armament, the pilot is provided with a telescopic or ring sight with concentric circles to gage deflection.

There is another phenomenon called the "Magnus Effect" for which no sights will compensate. This is induced by the spin imparted the bullets as they leave the gun barrel: in most guns, the barrel rifling gives the bullets a clockwise spin. When the gunner swings his armament for a left broadside and fires, the spin causes the bullets to drop in their flight just as top-spin drops a tennis ball. Contrariwise, from a right broadside, the bullets would rise in flight like a golf ball given back-spin. The amount of this up or downward throw depends, of course, upon the ship's speed. When a bullet leaves the gun of a plane traveling at 400 miles per hour, it actually moves sidewise for an interval at this speed, which is two thirds of its muzzle velocity or forward speed. So that the gunner may follow the flight of his bullets, or their trajectories, throughout all this queer behavior, tracer bullets—to which are attached pieces of a phosphorus compound which is ignited by friction as it goes through the air—are employed. Every fifth car-



Official photograph, U S Army Air Corps

Gunners in multi-place fighters such as this Bell *Airacuda* must be quick on trigger; speeds of over 350 miles per hour make accuracy difficult

tridge in the belt is a tracer. In daylight, the tracer leaves behind a thin trail of grayish-white smoke; at night, streaks of blue and pink light, like fireworks. Aim is corrected by watching one's tracers.

IN FACT, the fire from the new multi-gun turrets is aimed wholly in this manner, the gunner literally spraying his firepower over the enemy water-hose fashion. The heavy-caliber aerial cannon shells are also tracer-aimed. Typical turrets are dome-shaped affairs having slits in which the guns are elevated or depressed, much after the manner in which observatory telescopes are raised and lowered. The guns are also "swung" with the turret, the whole unit revolving, like the observatory dome, on roller bearings. Hydraulic power, derived from pumps geared to the engine crankshafts, rotates the turret with remarkable speed and ease as the gunner works the two (left or right) foot pedals. Trips or buttons are built into the gun handles with which he elevates the weapons. Thus, he has only to raise or lower the guns, squeeze the trips, and press a pedal to go into action. The finest of World War II turrets are those manufactured by the Boulton-Paul concern of England. Into these squat cupolas are fitted four Browning .312 caliber machine guns, each of which shoots at the rate of 1200 rounds per minute. These turrets are installed in the American-built Lockheed *Hudson* bombers, the Blackburn *Skua* dive-bomber-fighter, and the Blackburn *Roc* dive-bomber-fighter as well as in Boulton-Paul's own *Defiant* fighter.

Strangely enough, the two-seater fighter was discontinued several years ago, both in this country and abroad, in the race for performance superiority. The two-seater is the only type of combat plane suitable for the highly touted, long-expected style of formation fighting under radio control. Furthermore, the extra armament is worth its weight in enemies—the B-P turret, four guns, hydraulic mechanism, ammunition boxes, and spare parts weigh close to 1200 pounds.

No warplane can carry too many guns. Today's fighting ships are built around their armament. This is referred to in terms of "firepower." The result of this firepower, in its application against enemy craft, is called "fire effect"; and this is influenced by the type of ammunition used, and several other factors. Greater fire effect is obtained when one's firepower is producing better results than that of the enemy. This is known as "fire superiority"—the object of any offensive action or combat: weapons are useful only to the extent to which they achieve this ultimate aim. Flashing speed and maneuverability are to no avail if one's firepower is too weak to gain a decision after overtaking an enemy ship. By the same token, the man behind the gun has much to do with the outcome of combat.

To be a gunner, this man must be short of stature and long on heart—guts, if you will. Small men are not at so great a disadvantage in the crowded turrets as bigger men would be· but today's gunners are big little fellows, literally. In addition to courage, they possess a keen eye, a clear conception of ballistics and mathematics; they are able to make quick decisions, yet they have certain qualities of coolness, restraint, or self-control under fire. The reincarnation of the multi-place combat plane and the tactical ascendency of the gunner have necessitated training of the type and amount comparable with that of the pilot. Notwithstanding this fact, the gunner remains just an enlisted man to the high command. With good fortune, and sufficient enemy planes to make him an ace—if he were in the front seat—he gets a corporal's stripes, or, at best, those of a sergeant.

Salute, Mister, when you meet a stocky, grinning chap wearing gunner's insignia and perhaps a stripe or two—he's earned them the hard way!

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SPEED-UP

What It Means to Aircraft for Defense

CONGRESS votes billions; the President speaks blithely of 50,000 airplanes; William S. Knudsen goes to Detroit and the newspapers carry stories of miracles to be achieved by the automobile industry, with entire airplane fuselages to be stamped out in one operation like the roofs of motor cars. Certainly airplane production has already increased, and a good many airplanes are reaching Britain. But the double task of simultaneously supplying Britain and building up our air defenses is not an easy one. There should be removed the fundamental conflict between the Administration and American industry. Our leaders in the War and Navy Departments must make up their minds as to what they want and standardize on a relatively few basic types. Changes must be avoided once a type has been definitely settled. Army and Navy inspection must remain careful but not fussy and time wasting. Engine plants must be built and equipped with machine tools and filled with at least semi-skilled workers. These broad outlines of what is needed to speed airplane production are perfectly clear and the American people understand them perfectly. We are a production- and machine-minded country; only adequate direction is needed to give us and the British huge fleets of warplanes.

Glenn L. Martin, Mr. Knudsen, and Major-General H.H. Arnold, Chief of the Army Air Corps, on a visit to the Martin plant during a recent tour of inspection

When we get down to details, however, what do the airplane constructors themselves think of the problem? Paul G. Zimmerman, an oldtimer in aviation, recently read a most instructive paper on this topic at the Aircraft Production Meeting of the Society of Automotive Engineers; his views deserve careful study.

It is essential, Mr. Zimmerman thinks, to remember that even an order for 500 bombers, representing an outlay of, say, fifty million dollars, is still not mass production in the automobile sense, and that it is much more difficult to plan for 500 bombers than for 500,000 automobiles. Once the new car has been put into production there is no great urge to change. With the airplane service, however, information and news from the war front may make it irresistibly tempting for the engineering department or the Army or Navy air services to issue change orders. A few miles an hour more in the air, a little more gun power, somewhat better protection for the occupants, and air supremacy passes momentarily from one fighting nation to another. A change may appear more than justified, but a few such orders may alter the whole production plan of the airplane factory.

That is one difficulty. Another is in regard to materials. When starting an approved airplane, the first problem is to place an order for materials. Bills or lists are prepared, checked by engineers, shop, stock rooms, and so on. In Detroit, when building a car, so much experience is available that almost no mistakes are made in ordering material. The picture is different with the airplane. "I have found," says Mr. Zimmerman, "that it takes about 50 airplanes with the full co-operation of the shop and the engineering department to make the materials list accurate and reliable. There is no more important procedure to the speeding up of airplane production than to make certain of the completeness and accuracy of materials lists."

Once upon a time an airplane just grew in one spot with all operations going on in one big floor. Now, as Mr. Zimmerman continues, "The less work actually done on the airplane proper the more easily the line can be speeded up. This means that all possible work should be done by sub assemblies at a bench or a fixed location."

Other suggestions made by Mr. Zimmerman are good erection lists; bonuses for intelligent supervision; and so on. There are few experienced men in aircraft production, and all those engaged in this sphere of work or entering upon it would do well to digest his remarks.—*A. K.*

EXPANSION

Aircraft Plant to Provide For More Bombers

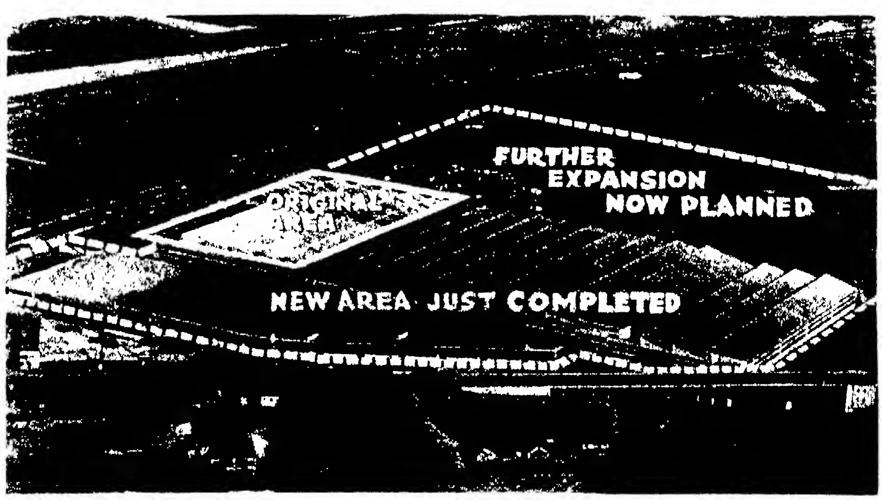
There are many valid reasons why it is easier to achieve mass production of the automobile than of the airplane. The automobile industry already has plants sufficient for its maximum capacity. The airplane people have to provide additional plant space for a production increase of at least 1000 percent in the short interval of a couple of years. Nothing illustrates what is happening better than the accompanying photograph of Boeing Plant No. 2 in Seattle, Washington, where the four-engined Flying Fortresses are being built. The original area of this building, four months ago, was 166,000 square feet and would have been ample for normal needs prior to Hitler's aggressions. The present floor area, just completed, is 832,000 square feet and would probably be sufficient were it not for the French collapse. The area now planned will give a total of 1,900,000 square feet There should be plenty of room to give both our own Air Corps and the R.A.F. enough of these splendid bombers which are so vitally necessary to present plans.—*A. K.*

"BLACKOUT" FACTORY

No Lights Will Show in Aircraft Plant

War in Europe has determined the design of a new factory for the Grumman Aircraft Engineering Corporation on Long Island. This new plant, which will cost over $2,000,000, will be a "blackout" factory—meaning that it will be windowless and that work will be carried on under carefully controlled conditions. There have been other windowless factories built but the emphasis in their design has been on efficiency of production, while the emphasis here is on the possible need for continued operation with no lights showing during bombing raids.

It will employ approximately 4000 persons who will work in an air-conditioned atmosphere under fluorescent tube lights, except in the assembly aisles where high intensity Mazda lamps will be used



What war orders have done to the Boeing airplane plant

The Inside Story of Rayon

When Wood Pulp Is Converted to Rayon, Just What Occurs and Why?

SIDNEY J. FRENCH
Assistant Professor of Chemistry, Colgate University

THE greatest fear of the lumberman, as he drives his winter's cutting down the rapid, swollen spring stream, is a log jam. It may cost him most of his cutting in logs torn and wrenched into matchwood by the terrific pressure of the ever growing jam behind. To prevent just such a catastrophe, nimble lumberjacks ride the logs, endlessly poking stray logs back into the current, lining them up for the perilous journey through a swift bottleneck. Should one log cross the current and lodge in unseen rocks, the jam is on, logs piling and rising up like giant fingers on all sides in a great brush heap. Dynamite may be the only solution.

On a lesser scale, a pile of jackstraws is the log jam. Anyone who has played the game realizes the difficulty of removing one straw without disturbing the jumbled, interlocked heap.

Carry the scale down to the submicroscopic, substitute infinitely small crystal logs, and you have the essence of the job which concerns the makers of the man-made fiber, rayon. He must take a jumbled pile of these tiny "logs"—logs so small that the highest power of the microscope will not reveal their presence—line them up in orderly fashion, tie and glue them together into a lustrous fiber of rayon. All this he must do literally in the dark, with his chemical reagents and his scientific reasoning.

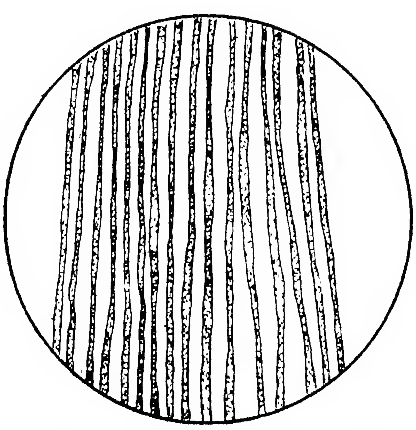


Figure 1: **Unravelled threads of rayon yarn, magnified 50 times**

Like most valuable commercial processes, the making of rayon was a successful art some time before science was able to explain what happened in the conversion of coarse wood fibers into sheer rayon threads. Thanks, however, to powerful microscopes, the even more deeply penetrating X-ray, and keen scientific reasoning, science is now able to picture the vital steps in the seemingly magic translation of cheap wood pulp into valuable rayon. Once explained, the steps seem simple indeed. But more important is the fact that an understanding of the scientific process leads inevitably to continued improvement in the value of the product.

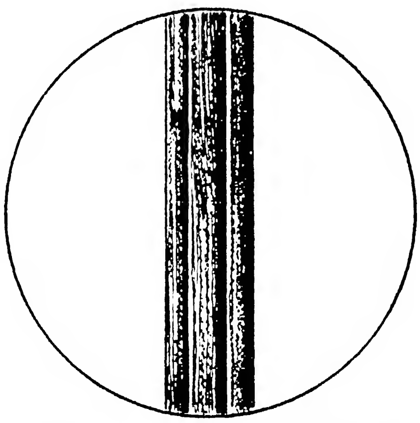


Figure 2: **A single thread of rayon, composed of fibers. X 500**

Like the Chinese, let us read this story backward, starting with a single strand of rayon yarn, examining it carefully, then probing even deeper into its structure and make-up by means of the microscope and the X-ray, carrying our investigation down even to the very atom, the fundamental building unit of all matter. This we may do by increasing magnifications till we have reached the limits of the microscope, and after that by picturing the probable structure as evidenced by X-ray analysis.

Figure 1 shows the unravelled threads which make up a single strand of rayon yarn, magnified 50 times. The threads are quite symmetrical and show little tendency to twist or curl. This is the important respect in which rayon differs from cotton. The twisted cotton threads reflect and scatter light irregularly, while the smooth rayon reflects it regularly to provide the well-known luster. In fact, manufacturers of rayon can, if desired, produce rayon with a sheen higher than that of silk; so high, in fact, that the lady objects and demands a softer luster. So the makers of rayon must leave some twist, some irregularities, in their threads.

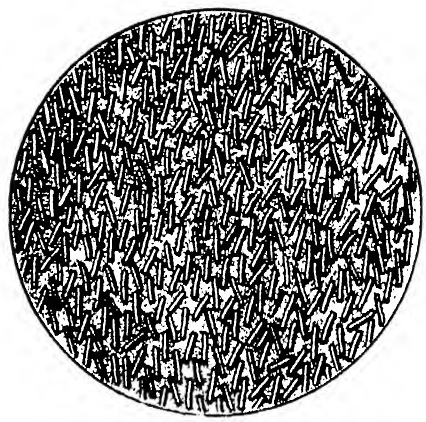


Figure 3: **Typical structure of rayon fiber, magnified X 5000**

Stepping up the magnification to 500 times, we next examine, in detail, a single one of the threads that make up the yarn (Figure 2). Instead of one solid thread, there are a number of fibers interspersed with apparently open spaces. Photomicrographs at this magnification are of considerable importance to the rayon technologist. They tell him whether the thread will take dye well, will have a soft or a high luster, will absorb moisture well or poorly, has objectionable impurities which must be removed in the manufacturing process.

Now we step up the magnification to 5000 times. We have reached the practical limits of the microscope (Figure 3). The single thread has been split apart and we are examining a single one of the fibers that make up the thread. Is this fiber a solid piece? No, it is actually a network having the appearance of matted felt. It is a jam of tiny crystal logs, but not

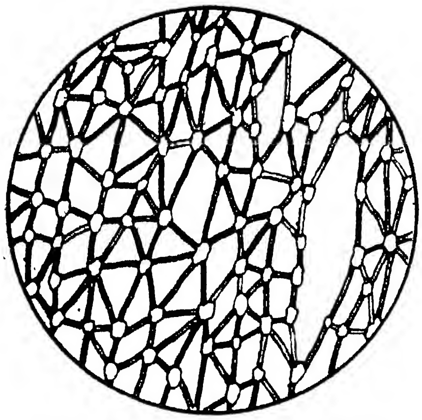


Figure 4: **The fish-net structure of rayon fibrillae, showing the crystal "logs," at an imaginary magnification of 50,000 times**

a bad jam, for the logs lie flat, none lies squarely across the current but all are pointed in the general direction of the fiber. These tiny crystal logs are known as fibrillae. Their lengths, their widths, their symmetry, and their directions are all important factors in determining the particular properties of the rayon thread—its softness, luster, elasticity, and resistance to folding or creasing. Still, we have discovered but little yet concerning the real causes of the nature of rayon.

WE MUST now pass from the realm of actual microscopic observation to that of indirect evidence based on the evidence of X-ray studies. We shall imagine a magnification of 50,000 times and examine, in detail, a few of the tiny crystal logs that make up the matted fibrillae (Figure 4). Here we have a true fishnet structure. The crystal logs are the strings of the net, knotted together with what the scientist, for lack of a better term, calls amorphous areas. The surprising thing is the apparent openness of the net, which at lower magnification appeared solid. It is this very openness, however, which gives to rayon many of its most important properties. A nice balance between open spaces and net is imperative in a good quality of rayon. Too tight a net means poor absorption of dye or moisture, little elasticity; too open a net reverses these factors. Uneven holes in the net mean weakness, unequal absorption of dye or moisture, irregular elasticity. Short logs and many knots cause the product to stretch too much; logs of irregular diameter reduce the sheen and cause irregularities in the thread. Again, the general direction in which the logs point is of great importance; they must all point downstream—along the fibrillae—but not in perfect alinement else the sheen is too high, the elasticity too low.

Are these tiny crystal logs actually single units, or are they in turn made up of still smaller units? Are the spaces between the logs actually empty or is there something there? To find the answer, we step up the imaginary magnification to 500,000. Figure 5 shows in detail the ends of a few of these crystal logs knotted together. Each log of the previous magnification has become a close bundle of parallel strands; the chemist calls this a micellar structure, a unit bundle built up of many molecules. The spaces between the logs, which seemed empty before, are now seen to be filled with loose, wavy strands. It is these loose strands, filling the spaces between log ends and extending loosely from one log to the next, which form the amorphous knots of the fishnet. And it is to these wavy strands that we are indebted for many of the important properties of rayon. They bind logs firmly together, end to end, yet provide for elasticity. They tie logs together side by side with a flexible glue which provides a strong network to withstand tension. They are responsible for absorbing and holding dyes, for absorbing and releasing moisture. If the strands are too few, the knots lack strength and the fiber breaks easily; if the crystal logs are not firmly glued together side by side, the thread is loose and disintegrates easily. These loose strands are, indeed, the internal cement, the amorphous glue, so all-important in a fine product. What is it that makes these strands so all-important, that accounts for their glue-like nature?

Figure 5: **Ends of crystal fibrillae, showing the loose strands which form the knots and glue. Imaginary magnification 500,000**

Let us look at one of these strands at an imaginary magnification of 5,000,000 times. We have reached a magnification where we can see the very molecule itself. Figure 6 shows the hypothetical appearance of these long molecules, each dot representing an individual atom in the molecule. It is, indeed, a queer looking affair in which six atoms are tied together to form hexagonal structures, and hexagons are strung together in a zig-zag manner. The wavy nature of the strands now is readily accounted for, as is the elasticity of the fiber. When the fibrillae are pulled, the hexagons are stretched out into line. They spring back into zig-zag position again when the tension is released. But most important to the properties of rayon are the arms reaching out into space on each side of the hexagons. These are what the chemist likes to call active groups—groups that, like glue, are eager to grasp something: molecules of dye, water, or even, perhaps, oil or grease. If there are other chains of molecules in the near neighborhood, they will grasp the outstretched arms of these chains. It is this close grasping of chain to chain which accounts for the building up of the crystal logs, the micelles of the fibrillae; while the active arms of the loose strands lying between the logs provide the glue to tie log to log, to fill the interstices between strings of the net, to unite with dye molecules, water molecules, or other foreign matter. Without these active

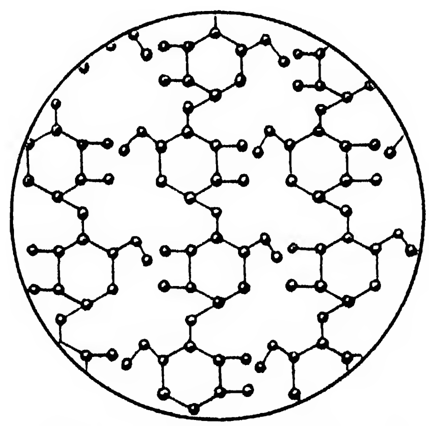


Figure 6: **Detailed appearance of single molecular strands, under an imaginary magnification of 5,000,000 times. Dots represent the atoms of the molecule**

fringes there would be no crystal logs, no network, no rayon.

As the final step of magnification, we observe what the chemist considers to be the fundamental chemical unit of rayon—under a magnification of 50,000,000 times. This unit, surprisingly enough, is *identical* with the fundamental unit of either wood or cotton cellulose, and bears a marked resemblance to a molecule of sugar. In fact, cellulose is easily converted into sugar by breaking the bonds holding hexagon to hexagon. Figure 7 shows the fundamental unit consisting of six carbon atoms, ten hydrogen atoms (which are omitted for the sake of clarity) and five oxygen atoms. These fundamental units unite to form the long strand molecules of Figure 6.

This, then, in brief, is the process of building up a single strand of rayon yarn. Fundamental molecular units unite to form long chains with active side-arms; these side-arms unite many chains into a compact bundle, a crystal log; loose strands form the knots and the glue holding the logs firmly together in a fishnet structure of fibrillae; these in turn are loosely held together by more strands to form the fiber; many fibers constitute a thread, and many twisted threads, a single strand of yarn.

There still remains one important question to answer. How is wood fiber converted into rayon fiber? Both have the same fundamental chemical units; both are structures of cellulose. But in wood fiber, unlike rayon, the crystal logs are in a log jam—interlocked, overlapped, and pointing in all possible directions. The first job of the maker of rayon is to break this log jam, dissolve the glue holding the logs at crazy angles. Then, he must straighten the logs out and send them on their way lined up to pass through the bottleneck side by side.

For the first step in the process, he uses chemicals — chemicals which tie themselves to the active side-arm fringes of the crystal logs—thus, in effect, dissolving and displacing the glue. In some cases he uses man-made glues to replace permanently that provided by nature. In others, he uses a temporary chemical which can be removed, once the logs are parted and re-alined. At this point, he has a viscous mass which is neither liquid nor solid, each log more or less freed from its near neighbors.

The next step is to line up these logs. This is accomplished by forcing the mass through funnels ending in tiny openings the size of a rayon thread. Each crystal log is swung and squeezed into line as it is forced through the ever narrowing opening.

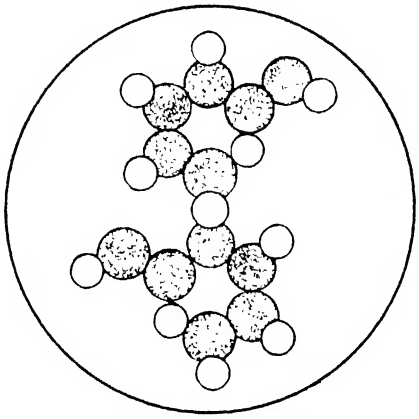


Figure 7: **The fundamental molecular unit of cellulose and rayon at an imaginary magnification of 50,000,000 times. Shaded circles represent carbon atoms, light circles oxygen atoms, hydrogen atoms omitted**

Were the product left in this state, however, it would be as weak as unhardened taffy—which, indeed, it resembles both in structure and chemical composition. The next step is to remove the chemical used to dissolve the glue and let nature's glue re-cement the logs in place—unless it is desired to retain a man-made glue. This is usually done by running the thread into an acid bath and allowing it to harden.

In the early stages of rayon manufacture, it was found that the threads disintegrated easily when washed. It was evident that the crystal logs had not been sufficiently lined up and glued together to resist the chemical effect of water. It was a simple matter to overcome this difficulty, once science had shown the reason for the weakness; the threads, before being allowed to harden, were stretched or placed under uniform tension. The result was to swing the logs more nearly into line, close up the open spaces in the net and give the glue a chance to act. However, care must be taken that the thread is not stretched too much—the logs pulled too closely together—else the thread loses much of its elasticity and tensile strength because the spaces between the strings of the net are squeezed out and there remains no place for either dye or moisture to take hold. Furthermore, if the logs are stretched too much, the resistance of the fabric to creasing is reduced, since this resistance depends both upon the overlapping of logs and upon a lack of uniformity in their directions.

Hence, the maker of rayon must strike a happy medium between stretching and relaxing; he must choose between strength and ability to absorb dye, brittleness, resistance to creasing, and many other factors. On the other hand, he can, merely by altering the tension, produce a variety of rayon yarns suited to a multitude of purposes. In learning to strengthen rayon, he has learned many other things about his product.

To make rayon, then, man has only to take the jumbled log jam of the crystals in wood fiber, unglue them, pull the tiny crystals apart, line them up, and re-glue them in place once more. But underlying the seemingly simple procedure, are many important principles which have taken science many arduous years to discover. The art of making rayon is rapidly becoming a science. It is still not an open book but many pages have been turned, many chapters read. In the remaining chapters, still to be read, lie, well hidden, additional principles which, added to those we already know, will make of rayon a fabric far superior to that we know today. No longer need the maker of rayon experiment in the dark to improve his textile. He knows what he must do, why he must do it, and with sufficient ingenuity he will find a way to do it.

• • •

BETTER GLASS

Makes Stronger, Smaller Bottles

A new technique in glass making, called Duraglas, resulting in a stronger and more durable container than was heretofore possible to produce, was announced recently by William E. Levis, president of the Owens-Illinois Glass Company. Duraglas has been placed in production at several of the glass plants under the company's operation, and will be available in quantities for the beer and beverage market immediately.

New architecture of the glass container likewise will contribute

both to its durability and its serviceability.

The new technique includes:

An exact determination of the fluidity of molten glass of various batch mixtures with resulting improvement in fabrication; improvements in batch mixing and automatic weighing, assuring absolute uniformity; better laboratory controls, governing raw material quality; simplification of glass furnaces and automatic feeding; modernized heat-recording instruments, assuring accurate furnace control; and further developments of the Owens automatic vacuum bottle-making machine, including synchronization of the melting pot to the machine.

FREQUENCY METER

To Study Vibratory Cycles

A NEW vibration frequency meter, weighing only eight ounces, and designed to aid the engineer in ferreting out the causes and cures of troublesome machine vibrations, is announced by the Westinghouse Electric and Manufacturing Company. The new instrument is no larger than an engineer's slide rule, but it can indicate what frequencies between 500 and 20,000 cycles per minute are present in a vibrating body.

This compact device is built around the principle of the vibrating-reed and consists of a thin spring steel vibrator clamped at one end between a set of steel rollers. A knurled knob connected to the rollers permits their rotation, and moves the steel reed in or out, changing its frequency of vibration. A sliding pointer on the back end of the steel reed indicates the vibrating frequency, which is read off the calibrated scale on the frame of the instrument.

Checking vibration frequency

To use the meter, its head is held against the vibrating body and the adjusting knob rotated until the vibrator reed moves to and fro at maximum amplitude. If more than one vibrating frequency exists, there will be a point of maximum amplitude for each, and vibrations in differing planes may be detected by changing the axis of the meter. The meter is very sensitive; it will indicate a vibration whose double amplitude is one ten-thousandth of an inch or greater. It can measure harmonics of basic vibration frequencies. Although not designed to measure the amount of vibration, it may be used as a rough indicator of its magnitude.

STATICLESS BELT

Prevents Accumulation of Static Charges

WHAT IS believed to be the first V-belt ever manufactured which prevents accumulation of static and retains its static-discharging qualities during its entire service life, is announced by The B. F. Goodrich Company. The belt will be sold, for the present, only to machine or equipment makers.

Wires dissipate belt static

This development in V-belt construction is of interest and importance to manufacturers and users of washing machines and other machinery where static discharges might create a fire hazard. These include gasoline pumps, other service station equipment, and machines in chemical, explosive, and milling plants.

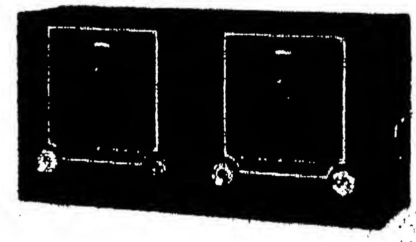
One of the important features of the new V-belt is the absence of any danger of the belt acting as a "short" between the motor and its operator. The resistance built into the belt is just enough so that the belt itself cannot act as a direct passage for current.

TIMER

Accurate for Industrial Operations

ANNOUNCEMENT of a tandem timer by the Industrial Timer Corporation brings public interest to the whole electrical timing field, a growing "infant industry." Until recently, it was impossible for industrial firms to control timed operations accurately by electrical means. Mechanical timers were subject to difficulties of adjustment and mechanical breakdown.

The new tandem is the first timer which can time-control both "on" electrical circuits and "off" periods. One example of its use offers potentialities never before realized in precise time: "Gaged-up" tandems—whole series of them—can be used to control mass production lines from start to finish.



Tandem timer for industrial use

Construction of the tandem is not made public at this time. Tandem timers, by Industrial, are the first and are believed to be the only timers in which precise selection of *both* "on" and "off" periods can be achieved, and single or continuous operation be effected.

WOOD BENDING

Chemicals Make Possible Permanent Bends

IT IS now possible to bend or twist wood into various permanent shapes, Dr. Elwin E. Harris of the Forest Products Laboratory, Madison, Wisconsin, said recently in an address on "Lignin and Lignin Plastics" before the Rochester Section of the American Chemical Society.

"Chemists can add a plasticizer to wood that will so soften the lig-

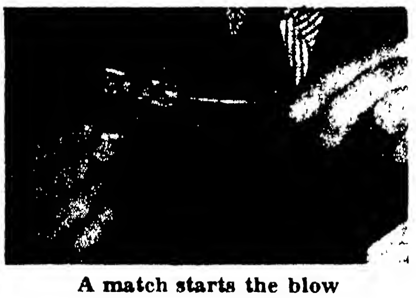
nin, which with cellulose constitutes the essential part of woody tissue, that when it is hot the wood may be bent or twisted into various shapes," Dr. Harris explained. "If it is then held in shape until it is cooled, it will retain the bent shape. The plasticizer has the disadvantage, however, that moisture causes the wood to revert to its original shape.

"Phenol and formaldehyde both react with lignin, causing it to soften. If wood is treated with such a mixture in a water solution, these chemicals enter completely into the structure of the wood, and if heated and pressed, a new wood composite is obtained in which a lignin-phenol-formaldehyde plastic holds the cellulosic fibers more tightly together than in the original wood. This new wood has much greater water resistance than the original wood."

MIDGET GIANT

Tiny Thermostat Strip Delivers Five-Pound Blow

A FEATHERWEIGHT strip of metal, its tenth-of-an-ounce frame bent and crimped like a hair-pin, snapped into action recently for the first time in public—showing how it controls electric power by tossing off five-pound blows faster than you can blink your eye. The heat from a match flame furnished the driving power.



A match starts the blow

Research engineers of the Westinghouse Electric & Manufacturing Company who developed the metal strip for regulating temperature in electric machines, have calculated that a replica of it, weighing as much as Joe Louis, could strike blows with a force of 160,000 pounds.

Development of the new control was announced by William J. Russell and Paul R. Lee. Its thin, slotted strip of metal, Mr. Russell asserted, can be made to work contacts to interrupt as much as 10,000 watts of electric power and maintain temperatures up to 1200 degrees, Fahrenheit, with as little as two degrees' variation.

This means that industry now has a thermostatic regulator some 10 times more sensitive than any inherently snap-action bimetallic thermostat previously used.

The scientific principle used to make the new thermostat open and close electric contacts has been known for centuries, but for 10 years the investigators have been seeking ways to control the amount and direction of metals' expansion and contraction. The final design is a bimetallic strip, slotted twice to distribute the stresses. Then the two outside strips, or "legs," are crimped to reduce their length. "This improves the snap action," Mr. Russell points out, "and also gives the piece stability and makes sure that it always acts the same way under similar temperature conditions."

CONTROL GAGE

Watches Width of Moving Steel Strip

A NEW photo-electric gage which gives a continuous and accurate indication of variations in the width of moving steel strip without making contact with the metal has been announced by General Electric. With the new device, the width of the strip can be measured "on the fly" at any point or points in the mill and variations from the required width can be accurately transmitted to any number of desired stations such as the control pulpit. Thus, while the strip is moving through the mill, adjustments to the edging rolls can be readily made by the operator to correct deviations from normal width.

This continuous method of measurement is in sharp contrast to present practice where the width is checked after the strip is delivered in coils from the coilers. By the time this manual checking is accomplished, several other slabs are in process of being rolled and on these no correction for width can be made. Obviously, undergage material means possible rejection while strip excessively wide might have to be side-trimmed. Thus the continuous indication offered by the new photo-electric gage should make possible substantial savings in time and material.

Although the gage was developed primarily for use on hot-strip mills, it can be readily applied to many other industrial jobs involving width control of moving strips of material.

In operation, both edges of the strip are followed simultaneously by narrow light beams and true indication of its width is given regardless of any sidewise movement of the strip. The movements of the light beams are photo-electrically transmitted to indicating dials.

MICROCHEMICAL

Doll-Size Tools For Infinitesimal Quantities

FOR some time now, modern chemists have been improving their technique in the analysis of quantities of material as tiny as one millionth of a gram. Such quantities — about one ten-thousandth the weight of an ordinary pin — are handled with extraordinary efficiency in the Westinghouse microchemical laboratory, as one example.

While we have discussed this amazing procedure before, we have never previously been fortunate enough to obtain so striking an illustration of the equipment used as the photograph on this page.

All the tiny test tubes, crucibles, beakers, and glass tubes shown in picture at right—enough for a wide range of experiments in microchemistry — would easily fit in the palm of one hand. Microchemical analysis is finding increasing use in many industries

INDUSTRIAL TRENDS

COLUMBIUM

If the already highly efficient steam turbine is to attain even greater efficiencies as a producer of mass power it will be necessary to operate it at higher temperatures. This raises a number of technical problems. One of these is to get a metal that will not creep unduly. Hitherto, special steels alloyed with such metals as molybdenum, tungsten, and vanadium have solved the problem, and it was thought that adding more of these metals would permit raising temperatures from 1000 to 1100 degrees, Fahrenheit. This is not the case.

According to a recent report, columbium dispersed in iron produces an alloy having greater strength at 1100 degrees than the carbide steels. At the General Electric laboratories this columbium-iron alloy—it isn't a steel—has been made by sintering powders of the metals and by casting, and the resultant product is the best yet at all specified temperatures, when due consideration is given to cost, ease of production, and machineability.

Columbium is a little-known, rarely used metal, discovered 140 years ago on this continent. It is the sister metal of tantalum and always found with it in minerals. When tantalum predominates, the ore is called tantalite, but it is columbite when there is more columbium. Columbium is inert to most acids and even surpasses tantalum in the property of absorbing and retaining gases at high temperatures.

FIXATION OF FRACTURES

While columbium has won new favor, its sister tantalum has been gaining laurels. Preliminary reports indicate that tantalum can be used to great advantage for surgical purposes because of its great resistance to corrosion. Over the past century the medical profession has tried out about every known metal with unsatisfactory and often sad results. Corrosion can cause necrosis of the tissue by liberating toxic metallic ions and by building up local deviations from the normal hydrogen-ion concentration.

Until now, an alloy of chromium, cobalt, and nickel, known as vitallium, has been most satisfactory in surgery. But this alloy risks the introduction of highly soluble and toxic chromium salts into the tissue. Furthermore, it cannot be machined and must be cast or ground. Tantalum, on the other hand, has shown no toxic effect whatever in experimentation, probably because the formation of a strong oxide film makes corrosion negligible. It is very strong and easily handled, which favors it for further trial.

OLIVES, CORN, AND CHEESE

Trade disturbance in the wake of war can be turned to advantage by the alert. Consider for the moment what is to be done to relieve the scarcity of olive oil.

An olive-infused corn oil has just been placed on the market which utilizes a process new to the food industry. It has been discovered that if ripe olives are salted, dehydrated, and macerated to form a paste, and this paste is infused in corn oil, a quite satisfactory substitute for olive oil is produced. The flavor and aroma characteristic of olive oil is present even when the product comprises 90 percent refined corn oil.

It would seem simpler to mix olive oil with corn oil, but even if the olive-oil content runs as high as 35 percent, it is less satisfactory than the product made with a 10 percent infusion of the paste, because the flavor and aroma of the olive is lodged in the meat. Heat employed during the infusion process has been found to retard the development of rancidity in glyceride oils.

The infusion process can be applied to most of the refined oils which are edible but unpalatable, such as those obtained from cottonseed, soya bean, sesame, peanuts, cocoanuts, palms, linseed, and sunflower seed.

Foreign cheeses are being supplanted by domestic products with a great deal of success and so the war boosts another industry.

PRODUCTION FOR WAR

Spurred on by the demand for speed and more speed, many new production processes and much revamping of the old come from the vast defense program. While strictly for the making of war materials, there will be commercial application after the war which will have profound influence on our conceptions of production. Here's one example:

There is a large machine now about to pass final tests which if successful will produce 3.325-inch shells at the rate of 480 an hour or something over 11,000 in a 24-hour day. It will take a slug of steel and, through forging and extruding operations, operated automatically, will form a shell needing only to be loaded and supplied with a nose. So skilful will be the work that no machining will be required.

Success of this new venture hinges on the ability of metals to stand the punishment of high heat applied continuously during the forming operations. If they can take it, shell manufacture will be speeded up more than 10 times.

ADD ANOTHER PLASTIC

Manufacturers now have a tough problem in selecting a plastic from the many on the market. Each plastic boasts its own peculiar combination of qualities and properties, and there is practically no limit to the combinations available.

Vinylidene chloride is one of the newest to make a bow. It has great tensile strength, toughness, resistance to fatigue and abrasion, resistance to water and chemicals, is non-flammable, has high dielectric strength, and machines and colors easily. It has been put into immediate use for leaders, trolling lines, and snells for fishermen. It appears as a bonding agent in new grinding wheels, and in the form of strong, flexible, rattan-like strands it has been woven to make seat coverings for use in public service vehicles where wear is severe.

CONFIDENTIALLY

A radical change in the ignition system of automobiles is being given serious consideration. If experiments prove successful, manufacturers may introduce it to the public on 1942 model cars.

—*Philip H. Smith*

The Brightest Known Star

Recent Search Reveals a Star Shining at Least 45,000 Times Brighter than Our Sun

HENRY NORRIS RUSSELL, Ph.D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

To find the star which looks brightest in the sky is no trouble, for Sirius happens to send us twice as much light as any other. But to pick out among thousands of stars those that are *really* brightest is another sort of problem. It would be fairly easy if we could measure the distances of the stars with precision; but the direct method, by measurement of parallax, has the disadvantage common to all range-finders. The greater the distance, the smaller is the angle upon which its determination depends and, for the remoter stars, even among those visible without a telescope, this angle is less than the inevitable errors of even the most careful observations. We have more accurate ways of finding the average parallax—and hence a kind of average distance—of groups of stars, but, in the absence of specific reason, we cannot be sure that a particular star in our group resembles the average.

Our best chance, then, is to pick out stars which have distinctive properties of one sort or another, get the average distances of groups so selected, by various statistical methods, and so find out by experience what characteristics are associated with high luminosity.

It is evidently useful to pick our stars by some property which is not affected by the distance of the star. The color of its light, for example, would be a pretty good choice; indeed, if we were to select stars of strongly bluish-white color, we would find them far brighter than the average. A more precise way of doing much the same thing is to select stars by the characteristics of their spectra.

Forty years and more ago, thousands of stellar spectra had been photographed and classified at Harvard. Miss Maury, while examining them, noticed that, now and then, one came upon a spectrum in which the lines were unusually strong and sharply defined (with the low dispersion employed). This peculiarity appeared in spectra of many different types, according to the ordinary classification. In the catalogue of spectra, it was denoted by the letter c—now used as a prefix to the symbol representing the ordinary spectral type—thus the spectrum of Rigel is cB8, and of Alpha Cygni cA2.

These spectra were picked out without any thought—indeed, at that date, without any knowledge—of the real brightness of the stars. Thirty-five years ago Hertzsprung—then a young man—pointed out that these "c-stars" had without exception very small apparent proper motions. Did this mean that their real motions in space were slow, or that they only seemed so because of great distance? Hertzsprung's discussion showed that the latter was the case. The c-stars were three or four times more distant than others of the same brightness and spectral type, and must be correspondingly brighter.

This was the first evidence that it is possible to get information about the real brightness of a star by looking at its spectrum, and led to the spectroscopic method of estimating absolute brightness and distance, which has already been used to find the parallaxes of more than 5000 stars. The later work has shown that the "c-characteristics" are the best method we have of picking out stars of very high luminosity—especially in the "early" types B and A. Enough stars of spectra cB and cA are known to permit a fairly good determination of their absolute magnitude, which comes out from -5 to -5.5, corresponding to a real brightness from 8000 to 12,000 times that of the Sun.

It was not till many years later that the reason was understood why unusually strong lines in the spectrum should be such good indicators of exceptional brightness. The spectral lines are produced, as everyone knows, by absorption (more accurately by scattering) of light in the atmosphere of a star. Hence strong lines must mean extensive atmospheres—if we signify by this, not depth in miles, but quantity of active material in the absorbing layer, in tons per square mile.

But the stars are not hot solid bodies, with overlying atmospheres; they are gaseous throughout. The only thing which keeps the light from reaching us directly from their intensely hot depths is that the stellar gases are hazy—they scatter light just as haze does on earth, so that a direct beam, like that of a searchlight, is soon depleted. The "depth of atmosphere" on a star is therefore a sort of shorthand expression for a depth such that the haziness prevents most of the light from the deeper layers from getting out. Other things—such as the temperature—being equal, anything which makes the gas less hazy will permit light to reach us from deeper down. It will find more of the absorbing substances in its way, and so the spectral lines will be stronger.

Compare, for example, the spectrum of Sirius with that of the Sun. Sirius is hotter, roughly 10,000° against the Sun's 6000°. This higher temperature should knock more electrons off the atoms, diminishing the number of neutral atoms but increasing that of those which have been ionized. We might therefore expect that the lines of neutral atoms (for example, of iron) should be weaker in Sirius than in the Sun, and those of ionized atoms stronger; but both alike are weakened, though the neutral atoms suffer most. It was once supposed that this happened because the temperature of Sirius was high enough to knock a second electron off most of the metallic atoms. But it is now certain that this is not true. The metallic atoms are in a rather better position to absorb many of their lines in Sirius than they are in the Sun.

The only reasonable solution is to assume that the atmosphere of Sirius is much more hazy, so that the actual quantity of material per square mile, above the depth to which we can "see," is much less. But why should the hotter atmosphere be more opaque? This we can answer. The haziness arises al-

most entirely from the presence in the atmosphere of electrons and of the charged atoms from which they have been ejected. At a temperature of 6000° most of the metallic atoms have lost an electron apiece, but very few hydrogen atoms, since it is much harder to ionize. Only the metals contribute to the haze—the hydrogen is clear. But, at 10,000°, a large part of the hydrogen is ionized, and there are many more haze-producing particles. The more hydrogen there is in proportion to the metals, the more conspicuous will be the change. From its actual amount, it can be calculated that, in the atmosphere of an average star like Sirius, there must be at least 100, and probably 1000, times as many atoms of hydrogen as of all the metals together. There must, indeed, be fewer atoms of hydrogen per square mile, above the depth to which we can see, in Sirius than in the Sun. The hydrogen lines are much stronger in Sirius; but this is a secondary effect. The visible lines are absorbed only by atoms in a highly excited state which are present in extremely small proportions at 6000°, but form a much greater fraction of the whole at 10,000°.

SUPPOSE now that there were some stars which contained a considerably smaller proportion of hydrogen than the general run. What would they be like? For comparison, we may reasonably pick stars from both sets with the same surface temperature, say 10,000°. At this temperature the atmosphere haze in ordinary stars comes mainly from the hydrogen. With less hydrogen the atmosphere will be deeper, but the amount of hydrogen above the depth at which there is a given amount of haze will be much the same. We should therefore expect the hydrogen lines to be not much changed, but the metallic lines to be greatly strengthened. In a fully developed case, we might find a spectrum very much like that of Alpha Cygni—a typical c-star.

If, at the same time, there was less hydrogen in the deep interior of the star it would be hotter inside, more heat would escape to the surface, and it would be much brighter in proportion to its mass. We know very little directly about the masses of the c-stars, but here is at least a partial explanation of their great luminosity.

Consider now an extreme case, of a star of fixed temperature, in which the hydrogen was reduced till it became less abundant than the metals and finally vanished. As this process continued, the atmospheric opacity due to the metals would remain, so that the "depth" of the atmosphere would not increase indefinitely, but reach a limit. The metallic lines would then

Photo by Ted Watterson, Palomar Mt.

Scale of the 200-inch telescope is shown by the man in the picture. You had to hunt? Is the man a dwarf? He has normal stature. The telescope would stump a Jimmy Durante, for his "Colossal!" would tell merely the true fact, fail to exaggerate

be very strong while those of hydrogen would weaken, and ultimately disappear. We should expect such a star to be even brighter than Alpha Cygni.

One good example of this is known—Upsilon Sagittarii, a star of the fourth magnitude. Its spectrum is packed with very strong lines of metals—mostly ionized, but some neutral—has weak hydrogen lines and rather strong lines of helium. This combination is almost without precedent, and suggested that this star was double—the metallic lines coming from a cooler component, and the helium lines from a hotter one. But—by one of the fortunate circumstances which sometimes help astronomers—the star is a spectroscopic binary, and shows large shifts of its lines due to orbital motion. These shifts affect the lines of the metals, of hydrogen, and of helium, in exactly the same way, both as regards amount and time. No more conclusive proof could be desired that the whole spectrum is produced by a single star.

It is only very recently that the solution of the puzzle has been provided, in the manner just sketched.

A thorough study of this very interesting system has recently been published by Dr. Greenstein of the Yerkes Observatory. The hydrogen lines, especially in the ultra-violet, are extraordinarily weak. Beyond the end of the hydrogen series there is a wide region of the spectrum in which hydrogen atoms exercise a continuous absorption. This, added to the opacity due to other causes, makes the "depth" of the atmosphere so small that the metallic lines, which are numerous in this region, are weakened almost to disappearance. Even in Alpha Cygni this effect is very conspicuous; but in Upsilon Sagittarii it is hardly perceptible. Greenstein's calculations show that hydrogen may nevertheless be more abundant than the metals, when atoms are counted; but, by weight, the latter predominate.

THE helium lines are so strong (despite the fact that they are absorbed only by very highly excited atoms) that helium must be very abundant, possibly 100 times more so than hydrogen. Greenstein, after a masterly discussion of a great mass of data, too technical to report in detail, concludes that this may be accounted for if the star has about 70 times the Sun's diameter, its surface temperature near 10,500°, and gravity at its surface about 1/200 that at the Sun's.

Not much is known about the star's real brightness. McLaughlin has estimated it from the intensity of the interstellar lines and finds an absolute magnitude of -7. Greenstein, from galactic rotation, gets -7.5. These correspond to 45,000 and 70,000 times the Sun's light. The estimated distance is 9000 light-years.

It is probable that this remarkable object is one of the most luminous in the galactic system. At least, it will be hard to find any brighter star. It might be picked out by its spectrum—provided that this could be observed with powerful enough instruments; but to determine its distance and real brightness would be very difficult.

A search in remote star-clouds and clusters is more promising. There is nothing in the globular clusters as bright as this, nor in the spiral nebulae — excepting, of course, the tremendous and evanescent supernovae. One star in the Small Magellanic Cloud is even brighter—the variable S Doradus, which has an absolute magnitude of -8.9, six times brighter than Upsilon Sagittarii. Among the stars visible to the unaided eye, however, the latter may well claim the title of the brightest.—*Princeton, November 1, 1940.*

Water For Our Greatest City

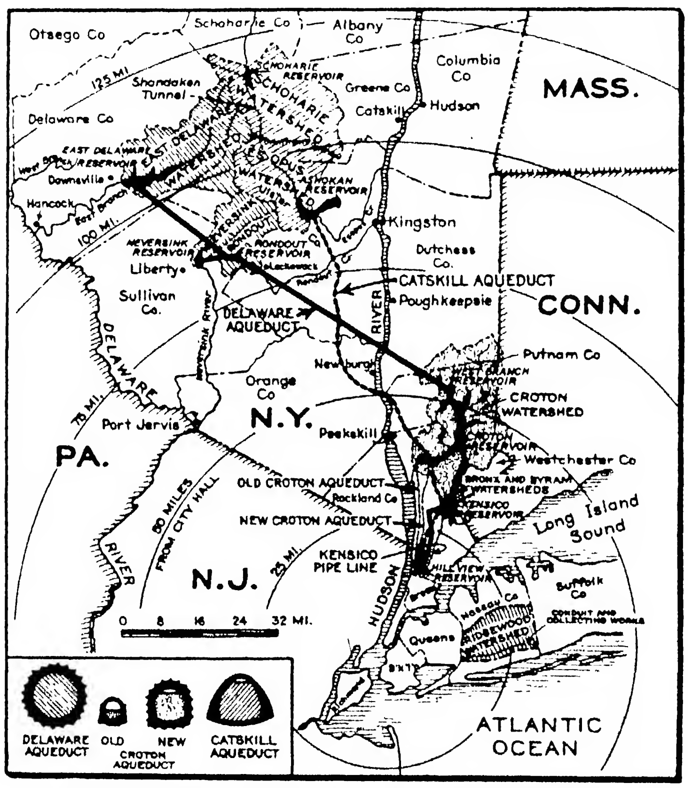
Longest Large Tunnel in World Is Deep Aqueduct to Bring More Water to City of New York

R. G. SKERRETT

THE City of New York, for the fourth time in the course of a century, is going far afield in quest of more water for her continually increasing population. Again, she will tap resources in the Catskill Mountains, west of the Hudson River, and make use of watersheds that do not contribute to the Catskill Aqueduct which has been serving all five boroughs of the metropolis since early in 1917.

During the past hundred years, the population of the City of New York has grown from 312,000 people to approximately 7,500,000, while the daily water consumption per capita has mounted from about 35 gallons to a figure of 131 gallons. Even more to the point, the rate of daily consumption is now millions of gallons in excess of the estimated *dependable* sources of supply. For this reason, the Board of Water Supply has specified that each section of the Delaware Aqueduct — the great project now in hand — shall be built in the shortest time consistent with good construction.

The work underway is the first stage of the Delaware Project, so called because it includes the impounding and use of flood waters of several streams originating in New York State on the southern slopes of the Catskill Mountains, that actually are tributaries, with one exception, of the Delaware River. That exception is Rondout Creek, which flows into the Hudson River; and on Rondout Creek will be created, by the Merriman Dam, the major reservoir of the Delaware Aqueduct system.



Route of old aqueducts and the new Delaware Aqueduct. Inset shows comparative sections of several

Water from the Rondout Reservoir will reach the City of New York by the longest and greatest series of interconnected pressure tunnels so far essayed. This three-unit conduit is now being driven deep in bedrock where, in case of war, it will be secure from gunfire, aerial bombs, and sabotage.

From its intake portal at the Rondout Reservoir to the Hill View-Reservoir, where the mountain water will be finally discharged, the aqueduct will have a total length of 85 miles. That immense rock-enveloped and heavily concrete-lined artery will have an internal diameter ranging from 13.5 feet throughout its first and longest section to a maximum of 19.5 feet throughout its last and shortest section. The conduit so proportioned will be capable of transmitting to the Hill View Reservoir — which is just outside the northern boundary of the metropolis and serves as the regulating and distributing basin for the city's water-supply system — as much as a billion gallons every 24 hours to meet an emergency. At present, the City of New York is drawing close to a billion gallons daily from its three aqueducts now in service and many municipal and private deep wells in Long Island. However, a considerable percentage of those wells are approaching exhaustion.

The Delaware Project will be brought to completion in three stages. The first stage, being pushed at this time, will include a dam on the Neversink River and a tunnel about six miles long that will carry water to a point where it can flow by gravity a short distance to reach the Rondout Reservoir. The Neversink River and Rondout Creek, together, are counted upon to provide a daily supply of 170,000,000 gallons for transmission through the long aqueduct tunnel. The second stage, which will be started before the present work is finished, calls for a dam on the East Branch of the Delaware River, to form a reservoir fed by a watershed having an expanse of 370 square miles. From that East Branch reservoir, 370,000,000 gallons of water daily will be carried to the Rondout Reservoir through a rock-driven grade tunnel 26.5 miles in length. The completion of the two stages will assure a total of 540,000,000 gallons daily of "new and additional" water to the City of New York and to a few lesser communities located along the line of the aqueduct and outside the metropolis. The combined cost of the first and second stages of the Delaware Project will be about $273,000,000.

The third stage of the development, for which preliminary plans have been made, will include the damming of three other tributaries of the Delaware River — all originating in New York State — and construction of tunnels that will take the captured flood waters to the Rondout Reservoir. This third stage will contribute an additional

160,000,000 gallons daily and thus raise the total to be carried from the Catskill Mountains by the Delaware Aqueduct to 700,000,000 gallons.

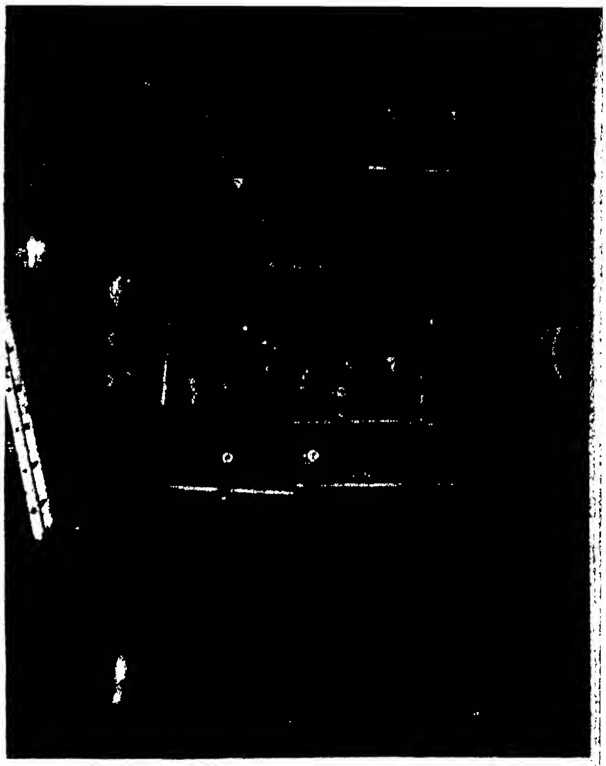
Although the primary purpose of the 85-mile aqueduct tunnel is to link the Rondout Reservoir to the Hill View Reservoir, engineers did not plan its course by the shortest, most direct line. Instead, the tunnel for its first section, with an internal diameter of 13.5 feet and a length of 44.6 miles, goes straight southeast from the Rondout Reservoir, passes under the Hudson River above Newburgh, and continues eastward and inland to discharge through an uptake shaft into the West Branch Reservoir, high in the hills of Putnam County. Through a downtake shaft there, the aqueduct will carry on southward—through a tunnel section 15 feet in diameter and 22.3 miles long—Catskill water plus 100,000,000 gallons from the Croton watershed. This admixture may be discharged into the Kensico Reservoir, at the southern end of this tunnel section, to mix with water coming through the older Catskill Aqueduct.

From Kensico Reservoir, the Delaware Aqueduct will take its flow through the final tunnel section, 13.6 miles long and 19.5 feet in diameter, to Hill View Reservoir, whence 100,000,000 gallons daily will be distributed by gravity.

The detour traced by the Delaware Aqueduct will render practicable the interconnection of all four of the aqueducts—something not now feasible; it will permit the unwatering of certain long and continuously used tunnel sections for inspection and repair; and, finally, the arrangement will compensate for deficient rainfall in any given watershed by drawing upon the probable abundance of the other watersheds.

The detour through West Branch and Kensico Reservoirs will also expose aqueduct water to the sweep of winds and to sunlight, so that objectionable micro-organisms may be destroyed. Furthermore, movement through the reservoirs will promote sedimentation of any solid matter suspended in the water. At the West Branch Reservoir provision will be made for chlorinating the water, if deemed desirable, before it enters the downtake shaft. Again, at Kensico Reservoir, the water arriving by the uptake shaft will, when required, be treated with a mixture of lime and alum to coagulate any suspended solid matter.

When the Board of Water Supply may not wish to deliver water from the Delaware Aqueduct to the West Branch Reservoir or the Kensico Reservoir, the flow in the main tunnel will be allowed to continue without interruption. Under West Branch Reservoir, a 15-foot by-pass tunnel 2.4 miles long is now being driven for that purpose; and a by-pass tunnel 2.3 miles long, and also 15 feet in diameter, has already been driven beneath Kensico Reservoir at a depth of more than 1000 feet. Gate chambers at both ends of these reservoirs will control the movement of water between the aqueduct and the reservoirs.



Drill carriage with seven pneumatic drills in a tu nel to be concrete-lined to a 13.5-foot diame

The Delaware Aqueduct Tunnel will be a full-pressure tunnel throughout its length of 85 miles, will be completely filled with water from end to end. In this respect it differs from the older Catskill Aqueduct which, throughout its length of 92 miles, has but five sections of pressure tunnels that total but 17 miles. The remainder of that system is made up of various types of partly filled grade tunnels and steel-pipe siphons.

To drive or excavate the 85 miles of tunnel for the Delaware Aqueduct, the work was started by first sinking 30 shafts located at intervals of from 2.1 miles to 5.2 miles. The deepest of these shafts, sunk in a mountain valley, has a depth of nearly 1551 feet. The 29 other shafts have depths varying from slightly more than 300 feet to a maximum of 1024 feet. Some of them were sunk only to offer more points from which to drive sections of tunnel, but others will later serve as aids in operating the aqueduct; as means by which tunnel sections may be drained for cleaning and repair; and also to provide connections with the aqueduct for supplying water to communities outside the metropolis.

From the bottoms of the shafts, all of which were sunk to the projected tunnel line, tunnel-drivers began their operations. In some cases, they advanced only a single heading from a shaft bottom, while in other cases, two headings moving away from the shaft in opposite directions were driven. The rock penetrated has ranged from soft to hard formations that have presented difficulties to the drillers. While most of the rock has been sound, in some places the rock has been fissured and carried large quantities of water. In one stretch of tunnel the rock has been rotten and filled with water, entailing a long and hard battle in safely advancing the excavation—requiring six months to go 152 feet.

In nearly all of the present tunnel-driving, each contractor has drilled and blasted the entire face of a heading at every succeeding step of advance, even in the largest of the tunnel sections. Tunnel-driving was started early in 1938, and since that time about 85 percent of the excavating has been finished, and the concrete lining has been placed in approximately 10 percent of the 85 miles of the tunnel. This remarkable progress has resulted from the intensive application of the most improved mechanical aids and by carrying on the work, night and day, in three shifts. In one section of tunnel that has an internal diameter of 13.5 feet, when lined—17 feet in the rough—an advance of 1863 feet was made in 31 consecutive working days. In that part which underruns the Hudson River at a depth of 600 feet, the contractor drove stretches at the rate of 40 feet a day. In driving sections of 19.5-foot diameter, excavated to diameters of from 23.6 to 25 feet, the advance was as much as 236 feet in a single week!

The foregoing records were made by mounting on a mobile drill car-

riage, at its forward end, from six to nine powerful pneumatic rock drills of wet types which minimize dust. These drills can bore from 42 to 90 holes at one setting. Depending upon the nature of the rock and the number of holes required in a face, the drilling time has been from one hour in favorable rock to six hours in hard granitic formations. After drilling, the carriage is shoved back from the heading 100 or more feet, and all the holes are then loaded with dynamite. The cartridges are so wired that a few holes in the center of the face are shot first to form a cavity. The outlying holes are then shot successively to move the blasted rock inward toward the center. Immediately after firing, the noxious gases are withdrawn through a large vent pipe leading surfaceward to powerful blowers. Then the course of the air is reversed, and about 12,000 cubic feet of air per minute is blown toward the working face to freshen the atmosphere so that work can be resumed within 30 minutes.

After a blast, the tunnel drivers remove the shattered rock or muck from the floor of the tunnel at the face and dispatch it backward to the bottom of the service shaft. There the material is loaded into one or more capacious skips or buckets and hoisted to the ground surface for transfer by large motor trucks to a spoil bank—usually nearby. The mucking is now done by a rugged electrically-driven machine that scoops up the broken rock and throws it backward on to a conveyor that drops the muck into a side-dump car shoved up close for that purpose. A muck train is made up commonly of six or seven side-dump cars, each capable of holding from five to six cubic yards of broken rock, and each train is pulled by a storage-battery locomotive. To shift each loaded car and to place an empty car at the end near the mucking machine, the contractors make use of different forms of "cherry pickers"—steel frameworks equipped with electric hoists that can pick up and lower an empty muck car. This apparatus obviates the use of switches. A muck car can be loaded in from one half to two minutes; and the mucking at a heading takes from 1½ hours to four hours.

At the surface, compressor plants of large capacity provide operating air for many purposes, while big blowers continually force fresh air down into the workings. Sanitary precautions, both underground and at the surface, keep the men in excellent health and working condition. Most of the workmen live away from their work, commute by motor cars and buses. Contractors' camps are a rarity on this great undertaking.

Probably the first section of the aqueduct that will be placed in service will be the 13.6-mile tunnel now building between Kensico and Hill View Reservoirs. It will be ready for use during 1942, and will permit the Catskill Aqueduct, between those two basins, to be unwatered and inspected after 23 years of uninterrupted service.

In the lining of the tunnel sections, we have today further proof of what can be done with the aid of mechanical facilities. For example, at this writing a 19.5-foot section of tunnel is being poured at an average daily rate of more than 2000 cubic yards! All these things are being done so that the unheeding citizens of the metropolis can have all the water they may expect whenever they turn their faucets.

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"PANCAKE" LOCOMOTIVE

Flat Design For Coal Mines

With an overall height of only 26 inches, a new electric mine locomotive made by General Electric for the Jewell Ridge Coal Corporation's mines in Virginia is several inches lower than previous locomotives of same weight and power.

The locomotive weighs 15 tons and is powered by two 90-horsepower motors. Equipment includes a 10-step controller, reverser, handbrake wheel, air-raised trolley, airbrake, air-sander, and whistle valve. Air reservoirs are contained in the two all-welded bumpers.

Savings are effected in costs by reducing the amount of top and bottom material requiring removal along main haulageways. The unit is able to operate in a 40-inch vein without brushing top or taking up bottom.

GROUND WIRES

Eight Miles of Them Plowed Under in Two Days

Ingenious constructors of the radio tower KFAR, near Fairbanks, Alaska, buried more than eight miles of heavy copper ground wires without first digging trenches. They plowed these cables 18 inches underground, radiating from the tower base every three degrees and extending to a distance of 500 feet in all directions. Hand methods of installing this amount of ground wire would have been both difficult and costly. A 25-horsepower Caterpillar Diesel tractor did the work in two days.

The plow rig behind the tractor resembles a modern farm rooter, with two high wheels and a knife-type blade between them. Fastened close behind the blade is a pipe, extending from the lower cutting edge to a point two feet above the ground. The wire was threaded through this pipe and fed into it as the tractor pulled the plow and packed the earth at the same time

Mine locomotive with an overall height of only 26 inches

Psusennes' Tomb

Not Even the War Sufficed to Prevent the Archeologists from Excavating in Egypt

ALBERT G. INGALLS

When wars hamper their digging, as World War II has been doing rather seriously, most archeologists simply shrug their shoulders and come home from the field. Some, however, find it practicable to remain in the warring country and go ahead with their excavating, so long as the battles do not touch the actual spot where they dig. Few wars touch all of a country all of the time. Moreover, the archeologist's attitude regarding wars differs somewhat from that of the rest of us. We live mainly in the present, its daily events tending to fill our horizon. The archeologist, dealing with the past as his vocation, is a dweller in all the centuries. He knows that men always have warred, yet that life always has kept on rolling along, so why should he become too excited about the squabbles going on in the period in which he happens to live? Hence he digs on, if he can.

Professor Pierre Montet is a Frenchman from Strasbourg University who, despite the current combat, has been excavating a magnificent tomb of the ancient pharaoh, or king, Psusennes, in Egypt. He discovered this burial at the site of the ancient city of Tanis, the Zoan of the Bible and the Sân of today, in the lower, northern, or delta part of Egypt where war knocks loudly as this is written in November.

Psusennes the First, second King in the mysterious, little-known 21st Dynasty of Lower Egypt, lived from about 1054 to 1009 B.C., or approximately three centuries later than Tutenkhamon. He was the father-in-law of King Solomon.

The exposed site, or top, of Psusennes' tomb is a flat square of massive stone masonry about 75 feet in each dimension. This square is the deck of a deeper stone structure down through which shafts lead to the burial chamber in the rock far below. In this chamber, about five feet in height, Professor Montet found a huge, rectangular stone box, the first sarcophagus of what was hoped would be a resplendent royal mummy. Such outer sarcophagi are hewn from a solid block of stone, with walls about five inches thick, and are provided with one-piece, hewn stone covers of considerable weight.

When this cover was removed the French archeologist found an inner or second sarcophagus of black granite, having the general shape of a human being but much larger — the object shown at the left in the photograph.

Nested within this enlarged human form in stone was the smaller sarcophagus at the right in the same photograph, yet this one was fully seven feet long. It was made of solid silver, decorated in colors—"the most beautiful object discovered in recent years." In the hands of this silver image, which is also shown on page 6, were the crook and flail, ancient Egyptian symbols of suzerainty, and on the head was the cobra, royal insignia, made of solid gold.

Next within was a six-foot silver and gold body covering which may be seen at the rear of the silver sarcophagus in the photograph. It has a solid gold mask.

The mummy itself was reached last, in the course of removal of one outer covering after another, but was found to consist of only a few bones. The tomb had not been robbed, but dampness had almost wholly disintegrated the body, not all of Egypt being dry and dusty.

Professor Pierre Montet bending over the heavy, solid silver sarcophagus of one of Egypt's kings. The same sarcophagus is shown on page 6. In the lower left-hand corner is the larger, hollowed granite sarcophagus in which the other one lay, neatly nested

What Makes 'Fantasia' Click

Multiple Sound Tracks and Loud-Speakers Give Auditory Perspective to Sound Movie Screen

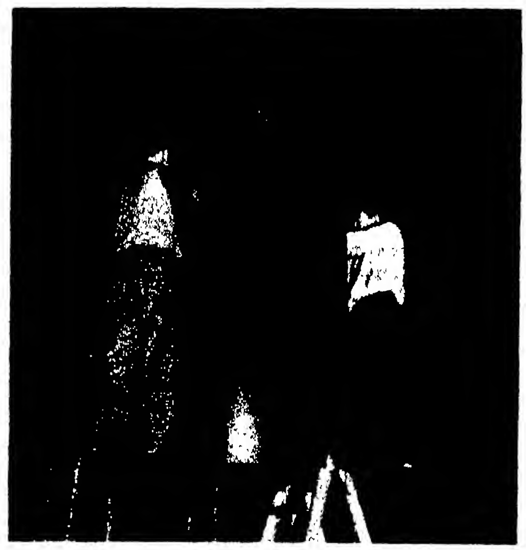
A. P. PECK

When Walt Disney planned the motion picture "Fantasia," he was working toward a two-fold change in the entertainment world. First, as the daily press has already well told, he was correlating classical music with pictorial and visual pattern interpretation. He was anticipating the introduction, in sugar-coated form, of great music to the masses. Secondly, and perhaps of more genuine significance, he was working with a sound reproduction system for movies which would bring to motion-picture audiences this great music in all its glory, in a form closely approximating that enjoyed by the privileged few who attend symphony concerts.

In co-operation with engineers of R. C. A., and with the aid of Leopold Stokowski and the Philadelphia Orchestra, the Disney studios turned out a masterpiece of the sound screen. The effects achieved — Mickey Mouse as the Sorcerer's Apprentice; ostriches, hippopotami, elephants, and alligators as ballet dancers in the Dance of the Hours; spouting volcanoes, dinosaurs, and pterodactyls in The Rite of Spring; and so on—have been so widely discussed as to need no further encomiums or criticisms here. The "how" of the sound system is something else, however, and, in this writer's opinion, constitutes the most interesting phase of the production. The implications of the new system are such as to hold great promise for the future of the sound screen.

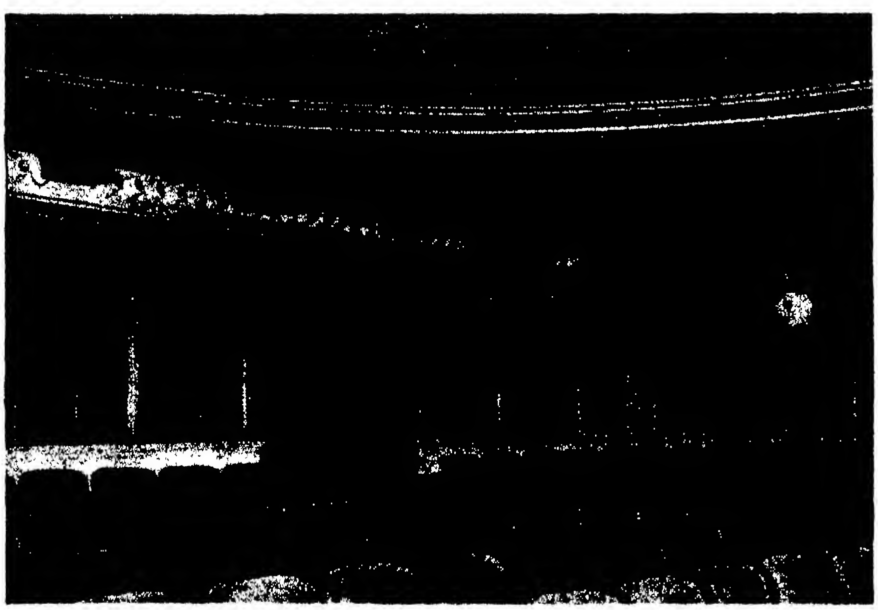
From the outset it must be understood that this sound system cannot be used with the regular movie-theater equipment of today. Also, production costs are high, and, at the time of writing, there is only one theater (the Broadway, in New York City) where "Fantasia" can be properly shown. The reasons why will be readily grasped from the description of the equipment. Disney's plans, however, call for a minimum of 12 projection units, spotted throughout the country, where equipment will be installed that can present this film, and other films to come, in their proper sound setting. How many more than 12 will follow rests with public demand.

Some appreciation of the results obtained in "Fantasia," and of the technical problems involved, can be gleaned from these figures: The range in decibels (sound volume units) of the best conventional sound-on-film production is about 35 db. The range of a symphony orchestra is about 70 decibels. In "Fantasound," as the new system is known, the range is about 75 decibels. Hand in hand with this greatly increased volume range goes a correspondingly increased range of tonal frequencies and hence quality of reproduction. With "Fantasound" it thus becomes possible to approximate closely the symphonic effects heretofore so definitely lacking in sound movies.



One of the large speaker units located in the theater balcony

Basically, the principles of present-day sound movies do not differ materially from those described by the writer some 13 years ago in these pages. There are still the microphone that translates sound waves into electrical impulses, the sound-modulated light that creates the sound track on the film, the photo-electric cell that re-converts the sound track to electrical impulses, and the loud-speaker that re-creates the original sound from these impulses. During the intervening years, of course, there have been refinements and developments that have improved quality, broadened the originally restricted frequency range, and so on.



Only a small part of the loud-speakers used in reproducing the sound of "Fantasia" are shown in this view of rear of the Broadway Theater

In the conventional sound film, a narrow longitudinal strip—between the edge of the picture and the film perforations—carries the sound record. This track is present on the "Fantasia" film also, but only for emergency use. If the high-quality sound system should fail, for any reason, this track will permit the show to go on, but it will function only in the conventional manner and with none of the exquisite quality of "Fantasound." This quality depends on a second strip of standard movie film that runs in a specially de-

An operator inspects one of the picture projection arcs. As in most theater installations, the projection machines are installed in multiple units

Chief Engineer W. E. Garity, of Disney studios, checking circuits on one of the amplifiers

signed sound reproducing unit. It operates simultaneously with the picture film and in precise synchronism with it. On the second or sound-only film are *four* individual sound tracks. In this multiplicity of sound tracks, and how they are made, lie the secrets of increased quality, volume range, and auditory perspective effect of the new system.

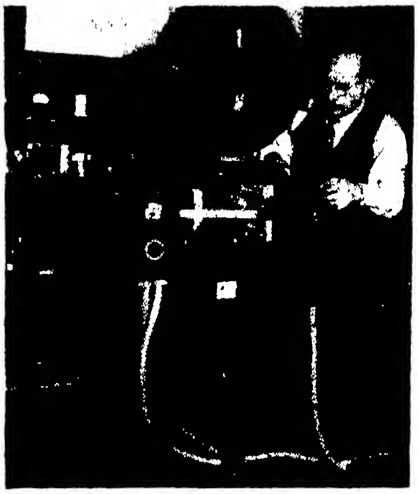
The first step in the production of "Fantasia" was to record a variety of selections played by the Philadelphia Orchestra. This was done by installing, on the stage, nine groups of microphones, each of which was connected through the usual amplifying equipment to individual sound-on-film recorders. Each of these recorders took care of a specific part of the orchestra—wood winds, strings, percussion, and so on. Thus it was possible to record the exact tonal quality emanating from each section, instead of forcing one sound track to record the over-all effect of a full orchestra, with the consequence of drowning out certain delicate passages or over-emphasizing others.

Now the nine sound tracks were shipped back to Hollywood where the real work started. Each of the tracks was placed in a play-back unit connected through three variable controls to amplifiers and to other recorders where new sound tracks were made from the electrical impulses. By means of the variable controls the operators could vary the volume of sound from any particular section of the orchestra, and, at the same time, the position from which the sound will be projected in the final production. (This "position" question will clear up presently.) By this process the nine sound tracks were melted down into three tracks that retained all the quality of the original music. These three tracks were again played back through variable controls and amplifiers to establish a frequency control track. Thus were obtained the four tracks that are used in the final film.

In the conventional sound movie, all of the reproduced sound comes from one or two speakers located directly behind the movie screen. The source of the sound is permanently fixed and, no matter where the characters on the screen may move, the sound always comes from the same position. With "Fantasound," however, there are a large number of loud-speakers located in various parts of the theater. In the initial Broadway Theater installation there are a total of 90 speakers, 36 of them being located back-stage and the remainder distributed throughout orchestra and balcony of theater.

By means of this varied grouping of loud-speakers, and the four tracks on the sound film, it is possible to vary the projection position of the sound for special effects. By proper control of the recording equipment the sound can be made to follow the characters on the screen with uncanny fidelity or even to "creep down the aisle" of the theater, if such a procedure should be desired. The sound tracks on the film do all the work. Three of them produce the program material; the fourth controls the position and volume of the sound as determined in the recording studio. It thus becomes possible to obtain a virtual auditory perspective effect. Suppose, for example, that the sound of a violin is to accompany the flight of a shooting star across the screen. The record of the violin sound will then start, say, on the sound track that feeds the right-hand speaker on the stage, will pass to the track for the center speaker, and end on the track for the left speaker, or possibly for speakers located on the left-hand side of the theater itself.

When the projectionist prepares for a program of "Fantasound," he, of course, adjusts his equipment to compensate for the sound absorption of a full house, a partially filled house, and so on. Otherwise, the film takes care of itself. The picture film is threaded in the projection machine. The special sound film is threaded in the sound machine, synchronism is checked, and everything is ready for the show.

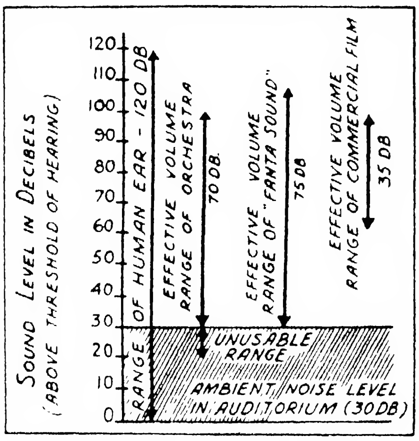


The projectionist inspects one of the special sound units in which is run the "Fantasia" film with its three sound tracks and the single control track

Perfect synchronism between picture and film is maintained through electrical interlock; it is impossible for the two films to run other than at the exact speeds desired and in precise unison. In the special sound machine a single light source illuminates the four sound tracks and is focused through a lens system on four photo-electric cells. Three of these cells, in turn, feed amplifiers and loud-speakers; the fourth, operated by the control track, produces the auditory perspective and extreme volume range effects.

Production and exhibition costs for this new sound system are naturally high. The complex recording process demands multiple units in every step. Many more thousands of feet of film must be used in production than would be required for a conventional movie of similar length. Projection of the film in the theater calls for special equipment; in the one theater initially equipped for "Fantasound" the cost approximated $85,000 for picture projectors, sound reproducing machines, and multiple loud-speakers, although "mass production" will reduce this about one half.

When sound movies first loomed on the horizon, as possible competitors with the old silents, there were those who said that they were a flash in the pan, that they would never come into wide use. And almost overnight the whole motion picture industry turned to sound. But it was sound coming only from one direction. Will the new "Fantasound" system cause a similar revolution in the entertainment industry? If first reactions can be depended upon, "Fantasound" indicates a trend.



Sound range in decibels of "Fantasound" compared with that of conventional sound film and of a symphony orchestra. Note that effective ranges of orchestra and of "Fantasound" extend downward to the noise level commonly present in auditoriums, and below which any sound would not be effective

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Fireless Steam Locomotives

The Successful Revival of an Idea That Was Considered a Failure Forty Years Ago

COMMANDER W. MACK ANGAS (CEC), U. S. N.

UPON first seeing a fireless steam locomotive at work as a switching and yard engine in an industrial plant, and upon hearing of the capability, efficiency, and economy of the machine, business-men, and for that matter many engineers, frequently ask if such engines are not a recent development in mechanical engineering. Actually the fireless locomotive is by no means new, the successful fireless switching engine of today having been produced by a revival of interest in an idea tried 68 years ago and believed at the turn of the century to be a demonstrated failure.

The idea of running a locomotive on steam drawn from an insulated pressure tank, charged at intervals by stationary boilers, dates back at least to 1864, when Mr. Zerah Colburn pointed out the possibility of using such locomotives in the underground railways then coming into use in London. No practical application of the idea was made, however, until 1872 when Dr. Lamm had one or more experimental fireless locomotives built for trial on the street railways of New Orleans. The engines gave such promise that, in 1875, eight engines were ordered from Theodore Scheffler of Paterson, New Jersey, for the Crescent City Railroad Company.

The Scheffler engines, which were described and illustrated in the October 20, 1877, Scientific American, were strikingly similar to modern fireless locomotives except for their diminutive size, which was due to the fact that they were called upon to pull only light street cars, and to the method of charging. Each engine had a cylindrical, insulated, pressure tank holding about 300 gallons of water which was charged into it at a pressure of 220 pounds per square inch and a temperature of about 390 degrees, Fahrenheit, from stationary water-tube boilers. Considerable difficulty was experienced in charging the engines with hot water, so experiments were made with a method of charging which introduced steam at 220 pounds pressure into the tanks through perforated pipes at the bottom. The steam condensed and heated the water until the temperature and pressure in the tank were substantially the same as that in the boiler supplying the steam.

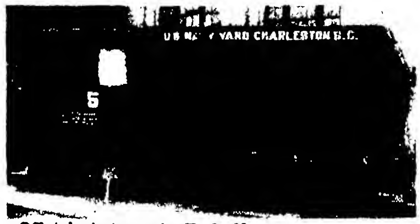
This method of charging fireless locomotives, the one in use today, was thoroughly developed and successfully used by M. Leon Francq, of Paris, who designed fireless locomotives which, in 1876, were put into use on a tramway in the

The opinions expressed in this article are those of the author, and should not be interpreted as those of the Navy Department, any of its bureaus, or the Naval Service at large.

vicinity of Paris, and others which went into service in 1878 on a line between Rueil and Marly-le-Roi. Articles written by M. Francq for technical journals of the late seventies show that he thoroughly understood the thermodynamic principles of the engines he designed. In these articles he explained that the locomotive was in reality a heat-storage rather than a steam-storage engine, the energy available in the steam in the top of the tank being trifling when compared to the energy stored in the hot water. As the engine ran and the pressure in the tank fell, this energy stored in the water became available, causing the water to boil and furnish steam until the pressure was gradually reduced to the minimum which would satisfactorily run the engine.

Other municipalities, among them Vienna, experimented with fireless locomotives on street railways and tramways but the development of practical electric traction systems in the eighties gave street railways a far more satisfactory motive power which was almost universally adopted. Except for an abortive attempt between 1898 and 1901 to revive a variant of the steam-storage engine under the name of the "Kinetic Motor" for suburban service on railways of Long Island and around New York City, and its adoption by the street railways of Batavia, Netherlands East Indies, where it is still in use, the fireless locomotive seems to have disappeared almost completely by 1905.

The revival of the fireless locomotive as a switching engine appears to have started in Germany. In 1913, Mr. Grant B. Shipley, of Pittsburgh, was shown a fireless yard locomotive at work in the plant of a Berlin locomotive builder and was so impressed that he purchased a similar machine for the Reed City plant of the Michigan



Official photograph, U. S. Navy

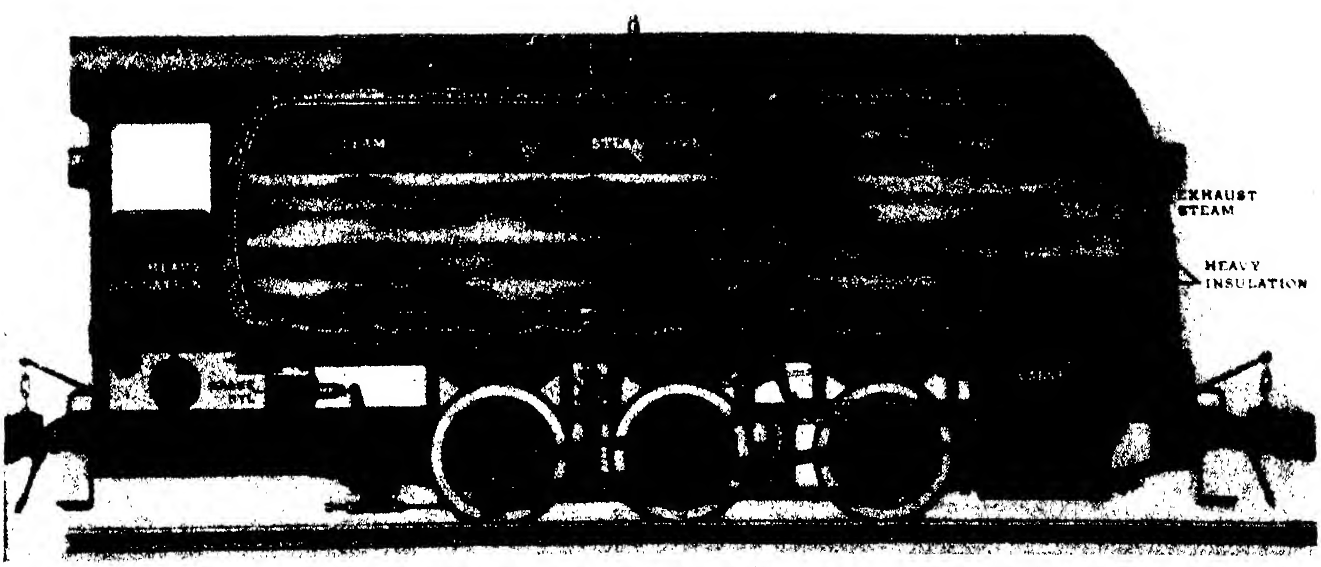
Fifty-ton fireless steam locomotive designed for 400-pound steam but now running at 160

Wood Preserving Company. The engine proved so satisfactory that within a few months a second one was ordered for the Ohio Wood Preserving Company's plant at Orrville, but the commencement of the first World War prevented delivery. Arrangements were accordingly made for the construction of a 22-ton fireless locomotive in this country. These two machines were followed by others.

By their surprising capability and economy, these engines attracted the attention of other users of switching engines. And the fireless yard locomotive appeared as a competitor of fuel-burning yard engines in plants where machines of the latter type could not be operated without risk. This development was fostered by the relatively high boiler pressures of modern power plants operated for general power purposes but available for charging the engines. Almost all such plants are now capable of furnishing steam at pressures in excess of the 125-pound minimum necessary, and many have 400- or 450-pound steam available for charging.

The first geared fireless locomotive, a 50-ton machine built for a maximum charging pressure of 200 pounds, was put into service at the New York Navy Yard in 1934. The two-cylinder engine of this locomotive runs at about four times the speed of the driving wheels, to which it is connected by reduction gearing, a jack shaft, and side rods. The thermal efficiency of the relatively small, high-speed engine of this locomotive is somewhat higher than that of the larger slow-speed engine which would be required for a direct-connected locomotive of equivalent power. Against this advantage, however, must be offset the disadvantage that the locomotive is slower, particularly when running light.

The Navy's second fireless locomotive is a direct-connected 50-ton machine recently put into service at the Charleston yard. Built for a charging pressure of 400 pounds in anticipation of the possible future installation of boilers working at this pressure in the yard power plant, it is now being charged with steam at 160 pounds and does eight hours work a day on two full charges and two partial charges, the full charges being obtained before the beginning of the working day and during the noon hour, and the partial charges in the latter part of the morning and afternoon when the engine happens to be near the



Diagrammatic cross-section of a modern fireless steam locomotive. Steam from a stationary boiler plant is introduced through charging pipe at bottom. Heat energy is absorbed by the water, which later turns to steam

power plant. These partial charges are taken in about 15 minutes each. With 400-pound steam from a test boiler, the locomotive has demonstrated that when fully charged to this pressure it will do heavy switching work for over four hours.

The Navy's two fireless locomotives are by no means unique as to size or charging pressure. Both engines are exceeded in size by many engines, the rather high designed charging pressure of the Charleston engine being exceeded by a 73-ton engine which takes steam at 450 pounds. The largest fireless locomotive built to date is a 95-ton, direct-connected machine taking steam at 350 pounds pressure.

The growing popularity of the fireless switching locomotive is due to its economy, safety, and convenience. The fireless locomotive is economical because its first cost is low, because the steam it uses is generated in the efficient boilers of a central power plant at a low fuel cost, and because it eliminates the boiler which is the most troublesome and expensive part of a fuel-burning locomotive to maintain. The safety of the machine is due to the complete absence of fire and explosion hazards. Its convenience is due to its constant readiness for intermittent work, and its cleanliness which enables it to enter buildings and shops without scattering ashes and blowing smoke and cinders about. Furthermore, its silence is a minor blessing to the office force if there are important tracks near the administration building.

From the above enumeration of its good points, it should not be concluded that the fireless locomotive is a universal panacea for all switching engine troubles. In many plants the mileage of track to be served, the absence of a boiler plant for charging, or other considerations may make other forms of yard locomotive preferable to the fireless, but nevertheless the fireless locomotive is an auxiliary tool the value of which industry is beginning to realize.

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Photo-Finishes

New Lighting Equipment Takes Last Element Of Chance from Horse Racing—Except the Horse

FRANCIS M. FALGE

JUDGING a horse race is no simple feat, and there can be no compromise for the fan who has put his two dollars on the nose of Ecstasy only to see Nerts' nose given first choice. Small wonder, therefore, that no expense has been spared to develop photographic methods of registering the finishes of horse races, now familiarly known as "photo-finishes," to take the guess work out of race judging.

Many racetracks, including Hollywood Park in Los Angeles, use the Photo-Chart Camera equipment invented and developed by Lorenzo Del Riccio, well-known in motion picture circles for his work with sound and color at Paramount Studios.

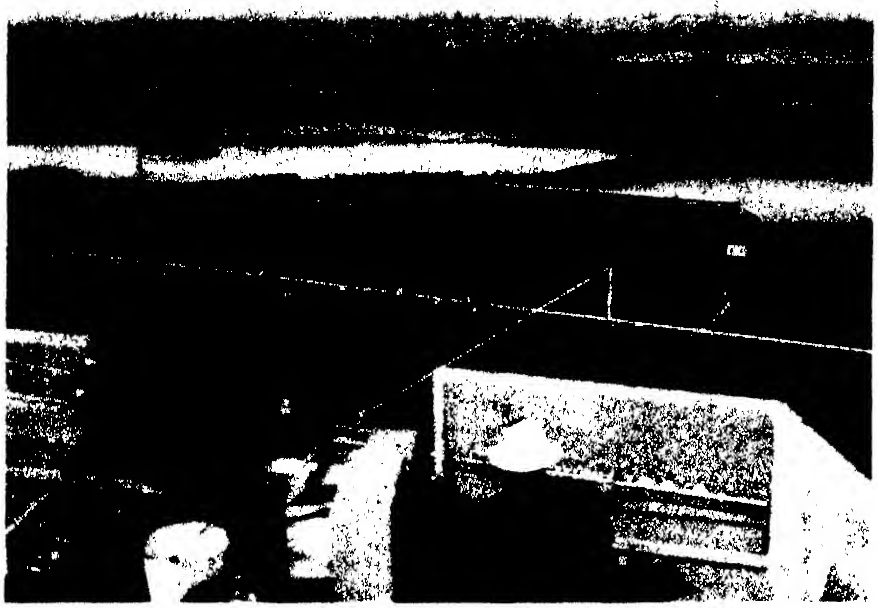
The principle of the Photo-Chart Camera, developed several years ago, is briefly this: Located at the top of the stands is the photo-finish camera as well as a complete darkroom for ultra-speed photofinishing. The camera is accurately aligned so that its narrow slit, 0.008 of an inch wide, is focused on the finish line. A telephoto lens of 5½-inch focal length and $f/2$ aperture images the full width of the track on the film which moves behind the slit opening at the same relative speed as the horses. The film speed averages an inch and a quarter per second, which gives each section of film approximately 1/35 of a second exposure. Because the film and horses are moving at approximately the same relative speeds, a short and undisturbed exposure of each horse is recorded, though, of course the background is completely blurred.

Interior of camera house showing the Photo-Chart equipment

In an average time of 48 seconds, an enlargement of the photo-finish negative is produced and delivered to the judges. With this equipment, dead heats, which have averaged 2 percent of all races, have been reduced to 0.5 percent with no dissension from fans, owners, or newspaper columnists.

Water-cooled 24-inch "sunspot" lamp used to illuminate finish line for photo finishes

The Photo-Chart equipment has provided accurate judging for all except the later afternoon races when the light is low in both level and direction and comes from behind the horses. Disturbing shadows result, which make judging difficult even with a photograph. To overcome this obstacle, Hollywood Park has installed the first 1000-watt, water-cooled mercury lamps for this purpose, engineered by Del Riccio and installed



A view from the spotlight equipment atop the grandstand, showing its location relative to finish line. Arrow indicates double lamp near ground

by the Keese Engineering Company of Hollywood. The mercury lamps were selected because of their high actinic value and small source, making control a simple matter.

Two lamps are installed in inconspicuous housings near the finish line. These illuminate the tape. Ballast transformers and water control equipment are all located in the same house. Atop the grandstand, at an angle of about 20 degrees to the tape from the Photo Chart house, is a 24-inch Mole-Richardson "sunspot" with a triple mercury lamp, with water-jacket equipment. The light from these lamps is directed in a narrow beam to the finish line, from the forward side of the horses.

With this extra lighting equipment turned on from the Photo-Chart house as the horses are in the stretch, adequate light is projected to the horses' heads to provide for late races and to erase shadows to permit accurate judging, thus removing this last bone of contention from horse racing. This now leaves but one variable, the selection of the horse itself!

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HUMIDIFIERS

Chemical Assists Home Humidification

SIMPLE open pan evaporators on radiators, designed for humidifying the home in winter, are cheap, but of little value because of the small amounts of water which can be evaporated from the exposed surface of the water. New devices called wick evaporators are more desirable because they expose a larger surface of water to evaporation. These evaporators are for sale in many hardware and house-furnishing stores, and from mail order houses. They are inexpensive and new wicks cost about 25 cents each.

In a wick evaporator, the capillary pores in the cotton fibers of the wick draw up water from the reservoir on top of the radiator and the water is then evaporated by the rising heat. The amount of evaporation, therefore, depends on the rate at which the water is drawn through the wick by capillary action. Carbonate salts in the water eventually plug up these capillary pores as the water is evaporated and, when one observes this, salt deposit, the wicks should be cleaned by soaking in a dilute solution of muriatic acid, using a glass or pottery container. If the wick of the evaporator dries up, the capillary pores fill with air and the wick needs to be squeezed under water to release this air.

Recently, the chemist has contributed to the market a product which will greatly increase the efficiency of a wick evaporator. The chemical, one of the "wetting agents," is of a type that has been widely used in industries to make water "wetter."

A small amount of a wetting agent, when added to the water in a wick evaporator, will keep the wick wetter and, because of the heat of the radiator, will have a marked effect on the amount of water evaporated and the relative humidity of the home. Also, if the evaporator should go dry and one must add water, the wick will immediately become wet and one can observe the air bubbles being released from the capillary pores of the fibers of the wick. Thus the necessity of squeezing the wick under water is obviated. Because these wetting agents are non-volatile, a few treatments a year in each wick evaporator is all that is necessary.

STACK "SURGERY"

Costly Plant Shutdown Eliminated by Electric Welding

BELIEVED to be the first of its kind ever attempted, an ingenious electric welding job has saved a large public utility company from a possible plant shutdown, with its accompanying financial loss, plus the additional cost of entirely new boiler stacks.

Upon inspecting two of the company's three 20-year old steel stacks, engineers found that the ⅜-inch steel center plates had been corroded down to as little as 1/64 of an inch; in some places they

"Operating" on a steel stack

found a full ¼ of an inch of rust. Cause was the corrosive action of combustion products from the forced draft coal fired boilers. In an effort to forestall a possible shutdown, the company called in the Weldrite Corporation, asked them to repair the stacks, if possible.

To solve the problem of supporting the top half of the stack so that the corroded plates could be removed, offset steel angles were welded across the faulty section. The old plates were cut out, leaving the stack's upper portion supported only by the angles. The prepared new plates were then inserted and welded in place.

Cost of repairing the two steel stacks with a Westinghouse Flex-Arc welder was less than one fifth the estimated cost of a new brick structure, taking no account of the expense of the shutdown which would have been necessary.

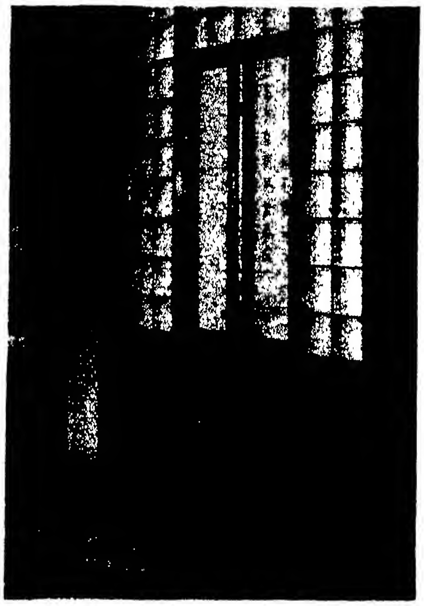
COLD-TINNING

New Process Has Wide Application

A new process of tin-plating copper and its alloys by cold dipping overcomes many of the difficulties encountered in the hot-tinning method, it is reported in *The Frontier*.

According to a manufacturer who is now using the process to tin copper and copper alloy tubing, it is possible to obtain an adequate coating on both interior and exterior surfaces of the tubing. The process, it is also claimed, is equally adaptable to straight lengths of tubing or to coils.

It is expected that the process will offer a satisfactory way to overcome the condition known as "green water." When copper and copper-alloy water lines are used, chemicals present in the water frequently react with the copper to form metallic salts. This condition is especially common when the water is drawn from surface wells, and may color the water perceptibly when flow is intermittent. While tinning the interior surface of the pipe by earlier methods gave reasonable satisfaction in preventing "green water," the process was limited to relatively short, straight lengths, was complicated, costly.



One-inch copper tubing in a wall-warming heating system

The cold process, in addition to offering a new weapon against "green water," is expected to find other applications in such fields as beer dispensing equipment and air conditioning.

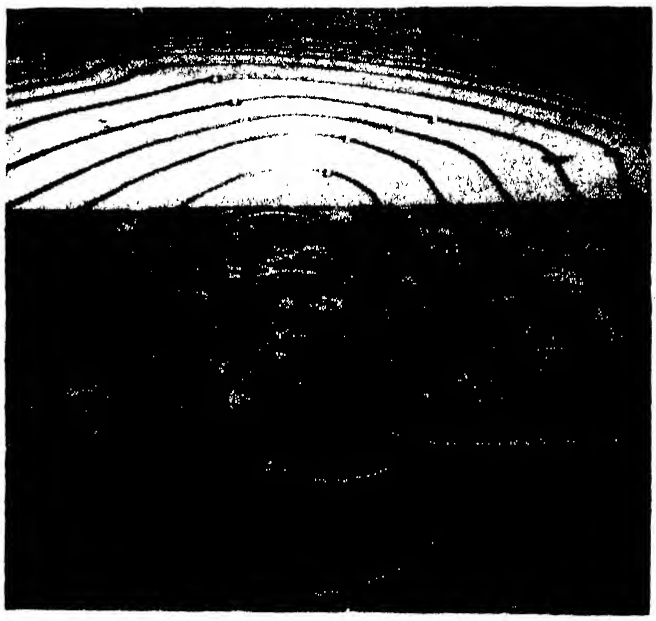
The method employs a solution prepared by the reaction of stannous chloride and sodium hydroxide to form sodium stannite, after which sodium cyanide is added. The internal surface of a tube can be coated merely by pumping the solution through the tube, it is claimed.

PANEL HEATING

Methods of Installing Pipes

More and more buildings and residences are being equipped for panel heating, the system which consists of the insertion of heating pipes within the floors or walls. In many respects this is far superior to the use of exposed radiators, primarily because, as research has shown, occupants of a relatively cool room will be more comfortable if the walls are warm; body heat radiates more readily and rapidly toward cold walls.

Panel heating is not new but, like many similar developments, its growth has been slow but steady. On the other hand, some of the methods of installing the pipes and the form these pipes should take are new. The accompanying photographs show methods of installing soft and standard copper tubes in



Photographs courtesy Copper and Brass Research Association

Two types of floor-warming pipe installations, before laying floor

Safety lighting. *Left:* **Three-level traffic intersection in New Jersey.** *Right:* **Lake Washington floating bridge**

floors and walls. Usually, in floor installations, a bed of gravel or other insulating material is laid under the pipes; in exterior walls cork insulation is mounted between the exterior wall itself and the piping system.

FRONTS

For Shirts — Like, but Unlike, Celluloid Collars

GONE — thank Heaven — are the days of the celluloid collar. Whatever else might be said of them, their flammability gave some of their wearers very serious burns when they caught fire.

Many advantages are seen, however, for waiters' and bellboys' uniform shirt fronts made of "Vinylite" plastic sheets. They are, of course, non-flammable, but they are also readily cleaned with a damp cloth, are completely resistant to spilled foods and liquids, and are permanent in shape and size.

HIGHWAY LIGHTING

Modern Systems Are Engineering Achievement

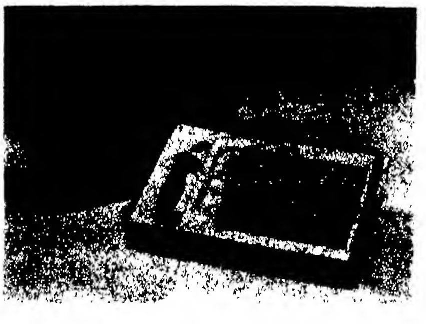
MODERN engineering achievements are shown off to their best advantage at night because of great improvements in outdoor lighting systems. More important, however, is the fact that these lighting systems provide illumination which is essentially glareless. So much research has gone into the development of such lighting systems that the result constitutes an engineering feat of no mean order.

Two outstanding examples are illustrated on this page. One shows the night illumination of the world's longest floating bridge, the Lake Washington Bridge, at Seattle, which consists primarily of 25 enormous concrete pontoons, as described some months ago in Scientific American. The lighting units used are sodium lamps developed by General Electric engineers. The other photograph shows the near-daylight illumination of the three-level traffic intersection on the New Jersey approach to the Lincoln Tunnel. The special system of illumination here was designed by General Electric engineers also. Reflectors direct light to the pavement surface, while little is lost upward.

FOR REFRIGERATORS

Deodorant Brick Renewed By Boiling Water

A MARKED advance in activated charcoal deodorants for refrigerators and iceboxes is presented in Syn-Char, a deodorant brick manufactured by R. MacKellar's Sons Company.



Instead of the usual granulated charcoal used for this purpose, Syn-Char is a highly compressed small brick, free from powdering and the resultant black dust and soot heretofore experienced with refrigerator deodorants. Also, Syn-Char lasts indefinitely, since it can be restored to its initial odor-absorbing state merely by placing in boiling water, followed by drying slowly in the sun, over a very low gas flame, or in a heated oven. This deodorant is of adequate capacity to keep the largest household refrigerator or icebox free of disagreeable odors, and also prevent the contamination of butter and other susceptible foodstuffs. Syn-Char is available for any "box" as an inexpensive accessory.

PETROLEUM FERTILIZER

Gaseous Ammonia Steps-Up Crop Production

IN THE West where crops are crops, they've been growing even bigger and better lately with gaseous ammonia blown into irrigation water. An acre of ground fertilized with 400 pounds of ammonia produces 736 crates of celery as against 565 crates from an acre dressed with a ton of mixed fertilizer.

Gaseous ammonia in its raw state is a petroleum gas, a mixture of methane, ethane, nitrogen, oxygen, and several other things. Intricate processing is required to make it suitable for agricultural use.

The gas is cracked and unwanted substances are removed. Cracking produces carbon, which is washed out with water and removed by electrical precipitation. This leaves a gas composed of hydrogen and small amounts of other unwanted substances.

This is only the beginning. Before ammonia is obtained, the hydrogen must be purified. This is done by putting it through iron

oxide boxes, an oil scrubber, a water scrubber, and two caustic soda scrubbers. Then it is ready for the final process of purification. This involves cooling the gas to 380 degrees below zero, after which the gas is washed through liquid nitrogen obtained from the air. The scene then changes to the synthesis plant where the gas loses the last of its oxygen and carbon monoxide and is synthesized into ammonia which emerges as a gas, ready for liquefaction or crystallization.

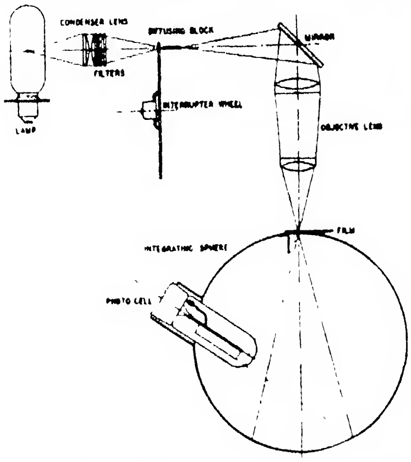
DENSITOMETER

Determines Density of Motion Picture Film

"LET one lightning-bug in a swarm of 500 stage a blackout and the Integrating-Sphere Densitometer can spot him!" That's how Dr. W. J. Albersheim, mathematical physicist of Electrical Research Products, Inc., described the precision of the latest optical instrument of show business. Not only does the new device boast a sensitivity five times keener than the human eye but, unlike the eye, it can tolerate the blinding glare of Hollywood's most powerful sun-arc without impairing its delicate perception in the slightest.

But the engineers who developed the new instrument were not concerned with lightning-bugs nor sun-arcs. They sought a scientific method of measuring the "density" or pattern of light and shade which comprises the image on a motion picture film.

To make such measurements, the Integrating-Sphere Densitometer traps that portion of a beam of light which succeeds in penetrating a test sample of motion picture film. The trap consists of a hollow ball or sphere, the inner surface of which is finished in white, and fitted with a photo-electric cell or "electric eye." Light entering the globular chamber is reflected many times and finally falls on the photo-electric cell as a thoroughly mixed or "integrated" product. Its value or brightness is then trans-



lated into electrical current and registers, in terms of density, on a meter. This information enables technicians to regulate with extreme accuracy the processing of movie film. Dr. Albersheim says the device will speed up the finishing operation and materially increase the uniformity of the final product.

Predicting behavior of movie film with the new densitometer

***Above:* Interior of densitometer, showing metal sphere. *Left:* Diagram of the optical scheme**

FOR BLACKOUTS

Sodium Lights and Blue Glass Windows

YOU won't have to pull down the shades or turn out the lights if the blackout of war ever comes to America. General Electric scientists, concentrating on United States defense problems, are working on a combination of light and glass which will allow daylight in through your windows during the day but keep light from shining out at night.

By pitting one color against another, the lighting experts are working on the problem confronted by war-torn Europe: the danger of lighted windows guiding enemy planes.

H. A. Breeding, physicist at the Schenectady lighting laboratory, disclosed recently that a combination of blue-painted windows and sodium lighting in homes and factories is one answer to this particular defense problem.

The paint to be used, Breeding said, is ordinary paint treated with a special blue dye, experiments on which are still proceeding. Windows treated with this special blue paint will admit daylight. But, more important in war time, homes and factories can be lighted inside with sodium lights, not one ray of which will escape through the blue windows.

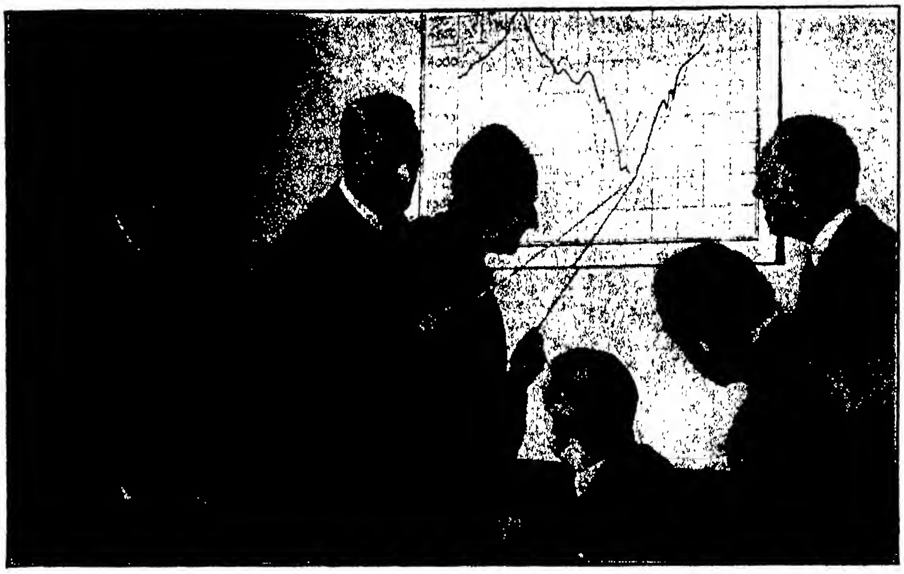
Of course, people might not like the yellow of sodium lights in their homes and factories as well as incandescent or fluorescent lighting; but, Breeding points out, this would be a minor inconvenience in war time.

PORCELAIN

New Frits Fire at Lower Temperature

THE daily bath is taken by Americans simply as a matter of course without much thought as to the background of research that has made it possible. Nevertheless, plebeian though the bathtub is, an enormous amount of research has gone into the development of new and better porcelains, improved methods of casting the iron base, and so on.

The seemingly unimportant reduction of the temperature of porcelain firing by just 200 degrees takes on great significance. The Porcelain Enamel and Manufacturing Company introduced, way back in 1911, new porcelain enamel frits which fired at 1600 degrees, which was just 200 degrees lower than those generally used then in the industry. The company has now developed another enamel frit, Pyroflex, which fires at only 1400 degrees. The first reduction was recognized as one of the biggest forward steps the industry has known, and is generally accepted as having been instrumental in



Study Your Leaders —Know What They Know!

IF you merely admire and envy the executive ability of leaders in business, finance, and industry, you will never be endowed with their capacity, or be able to duplicate their success.

To succeed on your own account, you must gain what they have and you lack: *an understanding of the entire field of business.*

A leader in business has a thorough grasp of the principles which underlie all successful businesses. If you could sit unseen, at his conference table, during the planning of an advertising campaign, you would see that he is guided by a broad understanding of the laws of distribution, supply and demand, the psychology of selling. Advertising to him is not a daring gamble—it is a powerful, measurable force.

And if you could observe his daily conduct of financial operations, you would see his decisions based on an understanding of the principles of banking, finance, investment. His entire management is guided by a thorough knowledge of organization, costs and credit. His policies are constructed with clear understanding of commercial law. He knows business as a whole.

This knowledge has been collected, classified and presented for your use in the Modern Business Course and Service of the Alexander Hamilton Institute.

Big men founded the Institute and big business leaders are contributing to the course. Among the contributors are such executives as Alfred P. Sloan, Jr., *Chairman of the Board*, General Motors Corporation; Colby M. Chester, Jr., *Chairman of the Board*, General Foods Corporation; Thomas J. Watson, *President*, International Business Machines Corporation; Edward R. Stettinius, Jr., *Chairman of the Board*, United States Steel Corporation; Major B. Foster, *Chairman*, Department of Banking and Finance, New York University, and many others.

What is the verdict of business men as to the value of the Institute?

Chief Engineer of a Public Utility:

"The Course has brought me, not only concrete practical ideas that were directly applicable to my own work, but has given me a much wider knowledge of business in general than I could otherwise have secured. No man today has time or money enough to spend in learning basic principles *by experience.*"

Vice-President of a National Bank:

"There is no doubt that, after having conscientiously followed the Course from beginning to end, one would be thoroughly acquainted with most of the problems that are to be met in the ordinary course of business. I am glad to recommend the Alexander Hamilton Institute Course to anyone who is interested in equipping himself with that business information which will enable him to improve his position."

We could quote hundreds more. These men are leaders. They have not only taken the Course themselves, but have watched its influence on younger men. Their judgment of the Course *must* be right.

Send for "Forging Ahead in Business"

The coupon will bring you a copy of this famous book which has helped so many other men to shorten their route to success. If you are one of the few who are asking, "What am I going to be earning five years from now?" you will send for "Forging Ahead in Business."

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ALEXANDER HAMILTON INSTITUTE, Inc.
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Modern Business

Name ....

Business Address ....

Position ....

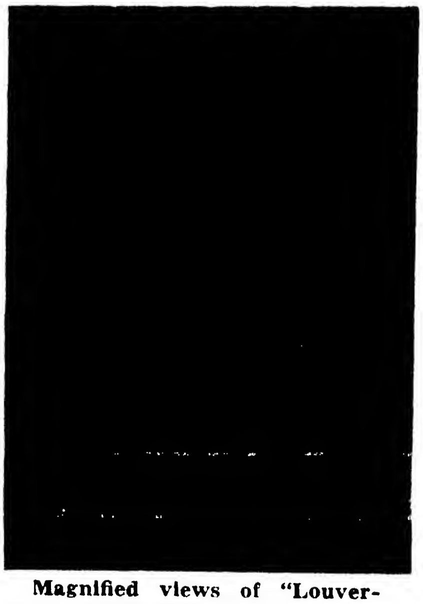
popularizing the wider use of porcelain enamel. This second reduction of 200 degrees permits the use of lighter gage enameling stock or black iron, thus greatly reducing manufacturing costs.

Pyroflex, as the name indicates, will withstand heat and will not flake off when bent or flexed. It may be applied in a wide range of colors, effects, and graining finishes, and requires only half the firing time of baked enamels.

PLASTIC WITH "SLATS"

Plastic Sheeting With Louvers For Lighting Fixtures

A NEW type sheeting has been developed in Plastacele, cellulose acetate plastic, with which it is possible for the first time, it is said, to combine the efficiency of direct lighting with the comfort of indirect lighting.



Magnified views of "Louverglas," edgewise at bottom, flat at top, showing translucent "slats"

Very thin, parallel, translucent louvers, or "slats," either white or colored, running through the depth of a clear transparent sheet at right angles to the surface, make possible this new eye comfort and bring other previously unattainable qualities to the lighting fixture field. The material also opens new possibilities in vision control.

This sheeting, called Louverglas, was conceived by L. C. Doane, President of the Doane Products Corporation, and developed in collaboration with the research staff of the Plastics Department of E. I. du Pont de Nemours and Company. It is the first material to combine in large measure the diffusion obtainable with an opal material with the directional efficiency obtainable with a clear material.

Louverglas is said to be the best material found to date for direct lighting fixtures for the new fluorescent lamp for which it is primarily intended.

According to the angle from which smooth-surfaced Louverglas is viewed, it appears as a transparent sheet with fine, parallel, translucent hair lines, which are the louvers, running through it; or as a completely translucent surface due to the louvers overlapping one another like the slats of a picket fence; or in various proportions of translucency and transparency.

For purposes where it is desired to cut off glare from all directions to the normal field of vision, one sheet of smooth-surfaced Louverglas may be used on top of another, with the louvers forming an egg-crate pattern.

Another innovation is Louverglas combining clear transparent plastic with colored louvers. There is no appreciable loss of lighting efficiency, as all but a negligible fraction of the light transmitted is through the clear transparent sections. Sheeting with black louvers, with which only direct light transmission is retained, will also have specialized use.

STRIP SEALING

Metal Foil Strip Covers Seams, Irregularities

FROM England comes news of rather wide use of a strip sealing process which employs aluminum foil to cover such surface irregularities as those along the rivet line of an airplane. Other places in which this strip sealing may be used is along the overlapping joints of any metal or wood construction.

To reduce friction or protect against corrosion under extreme conditions, the metallic foil, usually of aluminum, is coated on one side with a thermo-plastic adhesive. Before it is applied, the point to be covered is cleaned of any grease or dirt and given a light coating of a similar adhesive by brush or spray. The foil is then placed in position and low heat and light pressure are applied by means, preferably, of a special thermostatically controlled iron. When the joint cools, the metallic foil is securely fastened but retains its flexibility indefinitely. The covered surface may then be lacquered and finished in the usual manner by a spray or brush.

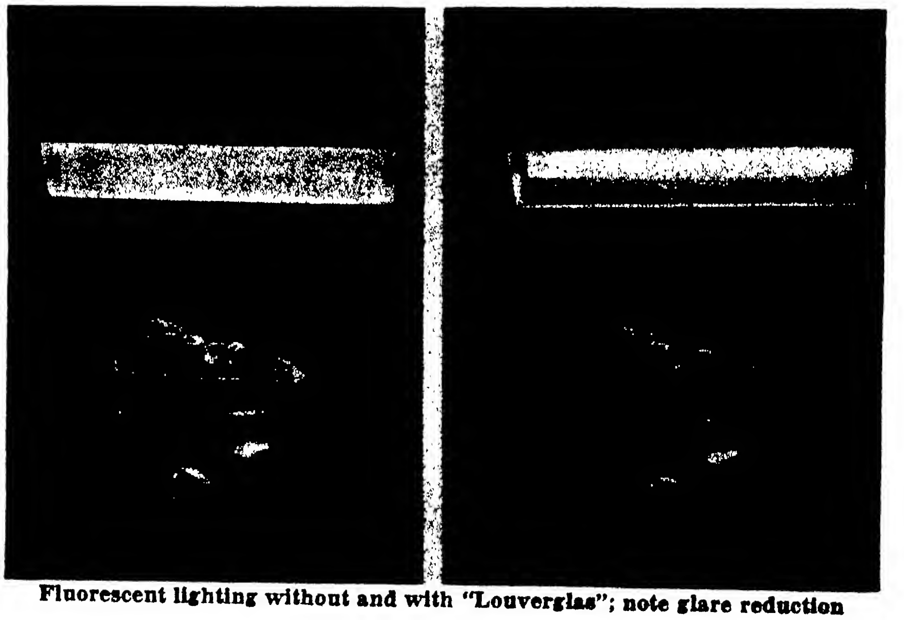
This process is a product of Cellon Limited, Kingston-upon-Thames, England.

WHIPPOOR-WILL

The Famous Bird, Often Heard, is Almost Never Seen

PROBABLY not one person in a hundred ever has seen a whippoorwill. Its melancholy song is one of the most familiar notes in the symphony of the summer evening but to the majority of listeners it is only a disembodied voice in the dark, for the singer has come about as near to achieving invisibility as any living creature, says Dr. Winsor M. Tyler in a bulletin issued by the Smithsonian Institution.

The whippoor-will is a migrant,



Fluorescent lighting without and with "Louverglas"; note glare reduction

spending its winters in Florida and its summers from March to September in the north. It travels entirely at night, sometimes in large flocks. It builds no nest but lays its flecked eggs on the ground, depending on the flickering shadows of the woodland over the dried leaves to conceal them.

The bird is masterfully camouflaged and usually selects a spot for its eggs where the woodland floor is free of underbrush and the trees are spaced far enough apart to cast an uneven shade. The newly hatched chick, almost exactly the color of the dead leaves among which it lies, remains essentially invisible. Nests are found almost exclusively by accident.

Dr. Tyler tells how one may catch a glimpse of a whippoor-will: "In order to study the whippoor-will at short range it is well to visit its haunts for a few evenings and learn how the bird behaves when it wakes from its day's sleep. Whip-poor-wills move about over a considerable territory when they come into the open for their daily session of singing and feeding. They follow a route, evening after evening, that varies little, and on the circuit there are stations—a stone wall, a low branch, or a certain spot on the ground—where they are almost sure to stop and sing for a while.

"If we seat ourselves near one of these stations where the light, which will be almost gone when the bird arrives, will favor our view, and where a dark background will obscure us from the bird, we shall be able to see the whippoor-will at short range, for if we sit motionless the bird will pay little attention to us. We must sit quietly and wait, following the song as it swings around the circuit, and we must watch the spot where the bird is about to alight, for, although in flight it looms big even in the dusk, when it comes to rest, with a flick of its wings it becomes a bit of dead wood, a clod of earth, or vanishes altogether."

PHENOTHIAZINE

Almost Universal Remedy For Wormy Animals

In the old days when animals such as sheep and cattle became infested with nodular and common stomach worms, the farmer or rancher could do nothing but guess at the kind of parasite and prescribe some anthelmintic which he hoped might work. If his guess were correct, the

organism would be eliminated by this worm expeller; otherwise his animals died. Yet, all the while there was in existence, says *The DuPont Magazine*, a synthetic product, phenothiazine, which is an effective treatment against most internal animal parasites.

It was not until recently that the anthelmintic characteristics of the pale, greenish-yellow powder, which is tasteless and insoluble in water and relatively non-toxic to animals, was found. First, investigators of the United States Bureau of Entomology and of the Du Pont Company began experimenting with it as a plant insecticide. Later came the discovery that, while deadly to certain insects, phenothiazine was relatively non-toxic to animals. This was the incentive for further experiments in the Zoological Division, Bureau of Animal Industry, leading to the development of the drug as an anthelmintic to remove several species of gastro-intestinal worms. Early findings proved it to be successful in removing common and lesser stomach worms, bankrupt worms, hookworms, large-mouthed bowel and nodular worms from sheep, as well as ascarids and nodular worms from swine, at least to the degree that they were not harmful to the animal's health. Later developments indicated its value for treating strongyles in horses, nodular worms and stomach worms in cattle, and for removing cecal worms from poultry.

Courtesy Jensen-Salsbery Laboratory

Veterinary administration of an aqueous suspension of phenothiazine to a variety of farm livestock

Phenothiazine is the only known anthelmintic that has proved effective for the elimination of various species of gastro-intestinal parasites, including those most commonly injurious to cattle, horses, and sheep. It is the only medicament that will remove nodular worms from swine and is an entirely satisfactory treatment for cecal worms in poultry. It will, in fact, remove more different kinds of worms successfully than any other chemical now known.

RECORDING PAPER

For Recording Instruments; Affected Only by Electricity

ONCE a closely-guarded secret, Teledeltos, the dry, electro-sensitive, recording paper which makes practicable facsimile telegraphy, long the dream of telegraph men, is now available for public use, the Western Union Telegraph Company has announced.

Numerous inquiries from manufacturers of recording instruments and from laboratories, colleges, and scientists who use automatic recording devices indicate a growing interest in this new recording paper.

Methods now in common use employ a recording pen moving across a paper chart, a point vibrating against a carbon paper record, a discoloration of paper by chemical methods, a marking by electrical discharges, and even photographic records made by moving points of light. These records show a wide variety of things, such as a time record of traffic, production performance of machines, water or electricity consumption, fluctuations of power and temperature, and so on.

Teledeltos paper has definite advantages for many purposes because it requires no developing, processing, or fixing, and records made upon it are instantly available. It is an electrically conducting sheet of paper coated with material which shows permanent changes of color at any point where an electric current passes through the sheet. The current is applied to the coated side of the paper through a metal stylus and the circuit is completed to a metal cylinder back of the paper. Neither the coating of the paper nor the record is affected by light or atmospheric conditions.

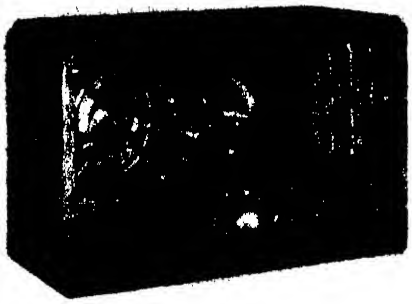
SOUND RECORDER

Records on Film— Speeches, Dictation, Conferences

A NEW instrument in the sound recording and reproduction field, making commercially feasible the non-photographic recording of sound on film and foreshadowing

a new era in the recording industry, has been perfected and is now ready for marketing and introduction to the public. The recording machine, to be known as the Recordgraph, was developed by William L. Woolf of New York and his associates, all radio engineering experts.

Mr. Woolf described his device as economically adaptable to business, social, and home markets. He explained that it can be used in amateur recording, for business dictation, and for recording conferences and meetings.



Panel of Recordgraph is lifted to show the interior mechanism

So precise is the recording operation that 96 sound tracks may be recorded on the conventional 35mm film stock. By the new process, 25 feet of film will support an hour's recording of speech or music of excellent quality, while as little as 6¼ feet will support an hour's recording of intelligible speech, at which rate the standard 1000-foot reel of film commonly used in the movies to supply about 10 minutes of entertainment, is sufficient to support 160 hours of continuous recording by Recordgraph. In the reproduction of recorded sound, the new machine may be instantly set at any one of the 96 sound tracks, making possible the reproduction of specific excerpts from any film record.

DIVING SUIT

Successfully Heated, Uses Glass Insulation

THE use of helium-oxygen diving gas has made possible deeper and more effective deep-sea diving. With this mixture, the diver is less subject to the bends, but he suffers much more from the cold than he does when he breathes ordinary air. It has, therefore, been necessary to supply artificial heat within the diver's suit by means of electric heating elements. With these there has always been the danger of short-circuits which could easily prove fatal because of the diver's contact with salt water.

New insulation made entirely of Fiberglas eliminates all chance for short-circuit, for this material is 100 percent glass and will not burn. This new heat-insulated diving suit, which marks an important chapter in the United States Navy's long record of piöneering development of modern submarine and diving safety devices, was announced recently at a demonstration by the Navy's Experimental Diving Unit in the Washington Navy Yard. It is being manufactured by the Colvinex Corporation.

MORE SELF-SUFFICIENT

Home Source of Previously Imported Insect Poison Discovered

PROGRESS in making America self-sufficient in her present war against injurious insects has been reported to the American Chemical Society by Drs. L. D. Goodhue and H. J. L. Haller of the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture.

Rotenone, a poison which is highly toxic to insects but entirely harmless when eaten by birds or mammals, has been found in one American weed known as "the devil's shoestring." During 1940 the United States imported about 7,000,000 pounds of root of the derris and lonchocarpus plants, which contain rotenone, in its fight against pests. Discovery of rotenone in Tephrosia Virginiana, the scientific name of "devil's shoestring," may lead to making this country independent of others for its supply of this material.

COVER SLIPS

War Shortage of German Glass Overcome By Americans

AMERICAN chemists and glass makers have overcome the threatened war shortage of an important German-made medical glass by learning how to make this rare glass here.

In reporting this fact, *Science Service* explains that the particular glass in question is the very thin and clear glass used as cover slips. Like the cloth slip covers used by careful housewives to protect furniture, these glass cover slips

are used to protect blood or other material being examined under a microscope.

Medical examinations of the men drafted for Army training will increase the need for this glass more than 33 percent, it is stated. During the World War, medical scientists were hampered in some of their work because this type of glass could be made only in Germany.

The glass, to be known commercially as Lustra Cover Glass, is extremely thin and practically colorless. Its thickness varies from 0.005 of an inch to 0.010 of an inch as compared with the normal home window glass that is 0.091 of an inch in thickness.

It would take a total of 36,000 separate ¾-inch-square cover slips to equal the amount of glass in a glass block 12 inches long by 12 inches wide by 1 inch thick.

CALLING ALL WORKERS!

To Build Iron Lung In Emergency

In an emergency, American workers always seem equal to special urgent tasks within their range of abilities. This is exemplified by the successful construction of an emergency mechanical respirator by 30 metal shop workers to save the life of a co-worker's 10-year old son, stricken with infantile paralysis in Grand Rapids, Michigan.

The youth, Cabell Pratt, son of Percy P. Pratt, western division engineer of Post Products Company, sheet metal fabricators, was stricken on a Sunday. Following a frantic but fruitless state-wide search for a respirator, the father reported his dilemma to the chief engineer and, at 9:30 Tuesday morning, the actual job of constructing the "lung" began. The 30 workmen toiled continuously for 28 hours, working all night Tuesday. Structural details were taken from one of two standard Drinker-Collings iron lungs in use at a local hospital, and an engineer produced the plans for the emergency unit.

Setting to work, the men cut the parts of the breathing machine from 14-gage sheet metal and arc welded the pieces together by the modern shielded arc process of The Lincoln Electric Company. Then they installed wires, valves, gages, and electric motors. The framework is of angle iron, arc welded. Portability is provided by six casters on which the unit is mounted.

The "tailor-made" breathing machine, completed at 1:30 P. M. Wednesday, three full days before the disease reached its crucial stage, was accurate to the last detail.

SKUA

British Plane Could Be Its Namesake

It has been said that the British fighting plane, the Skua, is named for a European species of sea-gull. There is another skua, living in the Antarctic, of which the British fighting plane might be more appropriately the namesake. For, according to a recent note from the

The iron lung that was built in 28 hours

Smithsonian Institution, this southernmost bird on earth is a fierce killer. Incidentally, it is the only higher animal except man and his dogs that goes close to the South Pole.

To carry out the analogy between the bird and the plane, this particular skua is a creature of relatively enormous strength, flying long distances while carrying chunks of meat bigger than itself. Furthermore, it is an extremely noisy, quarrelsome creature, but here the analogy ceases—if we are to be perfectly honest; it is utterly devoid of parental affection. The parents hardly bother to feed them, but the little skuas (like those British planes?) come out of the eggs fighting.

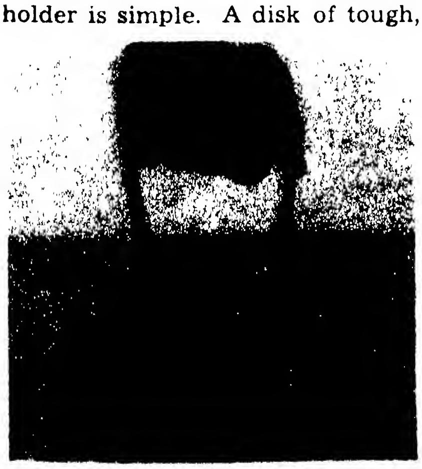
VACUUM HOLDER

Lifts Glass, other Smooth-Surfaced Materials

THE new style vacuum cup holder, or lifter, shown in our illustration, is a safe, sturdy, lifting device capable of holding as much weight as a strong man can lift, and its uses are practically unlimited.

The device, called the "Red Devil" vacuum cup, literally puts a handle on all kinds of glass as well as marble, granite, and various smooth-surfaced articles whose weight normally makes lifting, pushing, raising, lowering, or carrying awkward and difficult. It is being used in many refrigerator and range showrooms, and some automobile companies are known to be using the larger models for lifting solid steel tops onto the bodies. These holders are also highly effective in handling wallboard and numerous other materials on which the strong vacuum cup can get a grip.

Construction of the vacuum cup holder is simple. A disk of tough, durable rubber mounted on the bottom is connected through a central post to a hand-operated lever. When the device is placed on a smooth surface, this lever is thrown all the way over, as shown in the illustration, so that it lifts the center post, thereby lifting the center of the disk beneath, so that a strong "vacuum pull" is exerted.

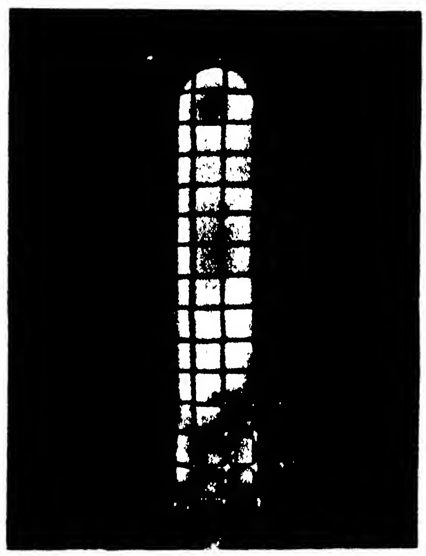


Versatile vacuum lifter

GERM-KILLER

Ultra-Violet Now Works in the Laundry

ULTRA-VIOLET rays have been used for several years to kill germs, fungous growths, and the like, in food packing and meat storage plants; recently a special ultra-violet ray lamp was developed for use in the home refrigerator. Now, for the first time, a special lamp has been developed "to bring sunshine into the laundry." An accompanying illustration shows this new lamp which has been designed for use in washing machines.



Sterilizing lamp for launderies

This washing machine germ-killer produces a high percentage of the ultra-violet rays that are the most powerful for the purpose—those of approximately 3000 Angstrom units.

BESSEMER BLOW

End-Point Now Determined Automatically

PATENTS were recently granted to Jones & Laughlin Steel Corporation on a new method for controlling the Bessemer blow. In this method, an arrangement of photo-electric cells and other instruments eliminate

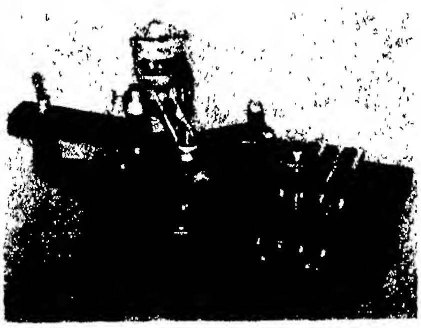
the human element in determining the all important end-point of the blow. Several major steel producers are expected to use the new method.

The determination of the finishing time of the blow of the Bessemer converter is important because, although the Bessemer process is essentially automatic in character and will proceed satisfactorily, the end-point is not automatic. Mr. H. W. Graham, under whose direction this development was made, says: "In fact, at a given moment the charge begins to 'commit suicide,' so to speak, by burning itself back into iron oxide." This change takes place with great rapidity; hence, precise control of the end-point by the ubiquitous photo-electric cell becomes a matter of greatest importance.

ENGRAVER

Pantograph Set-Up Uses High-Speed Tool

MANUFACTURING plants, experimental laboratories, and home workshops will find use for a small motorized engraver operating on the pantograph system. Called the Mico Engraver, this instrument will



Many industrial and home workshop uses will be found for this small engraving unit powered by a vertical motor. It will work a variety of materials

do engraving and light routing in steel, brass, sheet plastics, and similar materials.

The cutting tool is carried in a ball-bearing spindle that revolves at 10,000 revolutions per minute, the power being supplied by a small vertical motor mounted directly on one pantograph arm.

The pantograph set-up used has the advantage of having the master copy and the finished work directly before the operator, and, as the pantograph is three-dimensional and the type grooves are very deep, no damage results if the tracing stylus slips out of the letter groove. The three-dimensional feature also allows engraving on curved objects with simple attachments to gage the depth of cut.

The operator has the choice of four finished letter sizes from one set of master type.

X-RAY ANALYSIS

New Technique For Industry

A NEW technique for X-ray analysis of metals, alloys, welds, or small metal parts, which may be of great value to the armament industry as well as for peace-time work, was discussed recently at a convention of the American Society of Metals, by G. L. Clark, University of Illinois chemistry professor, and Dr. W. M. Shafer, Iowa State Teachers College chemistry professor.

It involves X-raying a thin specimen of the metal on plates having special, extremely fine - grain photographic emulsions, and then enlarging this negative 100 to 200 times. The original photograph is about the size of the end of a lead pencil.

The enlargement shows elements in the metal, whether they are spread evenly or bunched, as well as flaws or cracks. These flaws may be originally present or result from working the metal. Flaws in welds are instantly noticeable. Entire small metal parts may be X-rayed.

MITER KIT

A SMALL, well-designed miter cutter, complete with saw and selling at a modest price, is now being offered to professional and home craftsmen. Metal parts are cadmium plated; wood parts are of kiln-dried hardwood. Maximum depth of cut is two inches and the angle of cut can be adjusted through a wide range and locked firmly by a simple locking handle.

ELASTIC PAINT

For Coating Metals to Inhibit Rust

IF STEEL is kept absolutely dry—and that means that even the surrounding atmosphere must be dry—it will not rust. Yet even the best paints will let some moisture through. Therefore, a coating is needed that will exclude moisture and at the same time inhibit the

electrolysis which occurs where moisture does seep in.

A new product called Elastic Primer does both of these things. As a coating on iron or steel, it keeps out moisture because it forms a highly impermeable, rubber-like coating that expands and contracts with the metal under varying temperatures. Because of the nature of the pigment used, it inhibits the electro-chemical action that results in rust. The manufacturers claim that it never dries out hard and brittle but remains elastic so that it is useful for such things as ship bottoms, sky-scraper roofs, bridges, railroad cars, and the like.

DECIMALIZER

Finds Decimal Point

In Slide Rule Answer

WHEN a slide rule is used to multiply and divide a string of figures, it is extremely difficult for the user to determine the location of the decimal point in the final result. This is not news to an engineer,

but the development of the "Decimalizer" *will* be news. The inventor of this simple sliding device explains that with proper manipulation it is possible to determine easily just where the decimal belongs in the product or quotient of a complicated bit of slide-rule mathematics. As shown in our illustration, the Decimalizer is similar in construction and operation to the slide rule which it assists.

ALUMINUM SOLDER

Fluxless, Easily

Applied

THERE has always been much difficulty in joining or soldering aluminum and its alloys. Soldering the metal is an exceptionally difficult problem, and many soldering fluxes to remove the stubborn aluminum oxides have been attempted but with little success. The common practice of roughening the metal surfaces and brushing-in hot solder is admittedly not dependable.

No flux is needed, however, with the new Colaweld "T" Rod, the application of which is much like soldering. With it the surfaces of aluminum and its alloys need no roughening, and the absence of flux removes the danger of toxicity and burns to the worker, as well as corrosion of the metal. On most types of joints the rod is simply rubbed over the heated metal until the rod melts, or it may be applied with a hot iron moved back and forth over the metal to spread the molten rod until it "takes."

COMET

Will Be Conspicuous Around

New Year's Day

CONCLUSIVE evidence that the new comet discovered recently by Leland S. Cunningham, of the Harvard College Observatory, will be the most conspicuous since 1910 is contained in his latest calculations of its path. These have been made public by Dr. Harlow Shapley, director of the Harvard Observatory.

They show that, in early January, the comet will be easily visible in the western sky for an hour or two after sunset, as it passes south of the bright star Altair in the constellation of Aquila, the eagle. At that time, it will be about as bright as Altair, and possibly even more brilliant, though it is somewhat uncertain just what brilliance it may attain.

Its distance from the earth, at the beginning of 1941, will be about 60,000,000 miles, and from the Sun about 50,000,000 miles. It will be closest to the earth about January 10, when some 54,000,000 miles away, and to the Sun, with 33,000,000 miles, on January 16. Between these dates it will be most brilliant. However, it will then be so close to the Sun as to be seen, if at all, only in the evening twilight. Consequently, it will not be as conspicuous as earlier, when it has a dark background. In the closing days of December, the moon, in a crescent phase, will pass to the left of the comet.

Though several comets in recent years were just barely visible when one knew where to look, this will be the first conspicuous naked eye comet since 1910. In that year there were two: Halley's, making one of its 75-year visits, and another which appeared earlier in the year, and was so bright that it was discovered independently in the southern hemisphere by a number of persons. Later it was visible in North America.—*Science Service.*

CAMERA ANGLES

Conducted by JACOB DESCHIN, A.R.P.S.

Multiple Flash

INSTEAD of using one flash in one reflector, we use two or more in two or more reflectors, shooting all simultaneously with the operation of the shutter—that is the principal difference between straight or conventional flash photography and multiple flash work. Mechanically, this work requires a convenient means of hooking up so that the auxiliary flashes will operate synchronously with the main flash when the cable release actuates the synchronizing unit.

Until recently, multiple flash has been used chiefly by commercial and news photographers in photographing large groups or large areas. With the introduction of equipment designed to simplify multiple flashing, the use of this method has been extended to the ranks of the amateur and is being used extensively in carefully planned portraiture by outstanding photographers. In color work, too, its advantages have been great. Because of the small stops necessary to obtain the deep field required in color photography, and the slowing down of exposures due to the relatively low speeds of color materials, flashbulbs, duplicating the technique of regular lighting units, are practically a *must* wherever live models are being photographed. The use of multiple flash actually amounts to a speeding up of ordinary lighting units by supplying a great volume of light in an instant, although within the lighting scheme of regular flood-lighting equipment. The advantage lies in the fact that the latter might call for a longer exposure than is practical if subject movement is to be avoided and natural results achieved.

Figure 1

Figure 2

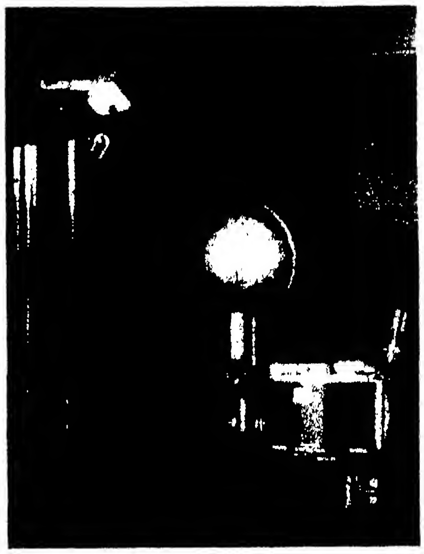


Figure 3

A number of the leading synchronizers on the market have provision for multiple flashing through extra sockets on the synchronizer battery case to take extra wires leading to auxiliary units placed at any required distance from the camera. The latest to appear, designed particularly for multiple flashwork, is the Chardelle Meteor kit illustrated in the accompanying pictures. With this outfit, the hookup is accomplished by means of a connector block screwed to the main unit and connecting the main unit with other units at a distance from the camera, all to be shot in synchronization with the shutter.

Figure 1 shows the set-up used on a Plaubel Makina camera. In this instance, only one auxiliary flash unit is being used. Wires lead to the connector block from the base of the battery case, from the base of the auxiliary battery case, and from the synchronizer unit screwed into the cable release socket on the camera. A cable release attached to the syn-

Figure 4

chronizer unit is plunged to set off the flashes and actuate the shutter.

A close-up of the connector block is shown in Figure 2, where it can be seen how the pairs of positive-negative contacts are arranged. Where it is found necessary to use more than the maximum of three flashing units provided by the connector block, additional blocks may be used on the auxiliary battery cases, each supplied with its own complement of cells, to augment the number of units and to distribute the lighting over a larger area.

Figure 3 illustrates a typical multiple flashing set-up, with the auxiliary light supported by a clamping bracket supplied with a swiveling head that screws into the battery case and permits direction of the extra unit at any desired angle. The unit may be clamped to any convenient support, such as a piece of furniture, a screen, and so on, or it can be screwed into a tripod supplied with a tilting head.

The average worker will probably find that two units will be all he needs, unless he wants to illuminate the background, which can be done with a third unit. In making the first few trials with multiple flash work, it is advisable to make the set-up with regular flood lights in order to study what the effect will be when the flashes go off. The two, or three, flash reflectors, are then placed in exactly the same positions previously occupied by the flood lights. After a little experience, you will be able to judge where the flash reflectors should be placed in order to achieve desired results.

Even spotlighted effects can be obtained with multiple flash lighting by having one lamp at or near the camera and the other near the subject, but above and to one side. Since the closer light is to predominate in order to provide the modeling light, as in the case of ordinary lighting, the unit at or near the camera should be far enough away, or its volume controlled by a diffusing screen. The reason for this, of course, is to weaken the latter in relation to the closer light. An example of the result of this technique is shown in Figure 4.

Diffusion Kink

For simple diffusion in enlarging, where only a slight softening is wanted, experienced workers recommend the use of a sheet of plain glass. The glass is held in front of the lens at a slight angle and is kept moving during the exposure.

Amateur Movie Makers

One of ten similar groups throughout the country, Continental Motion Pictures, of Kearny, New Jersey, is composed entirely of juveniles interested in movies. With Continental, these groups have formed the first nation-wide chain of amateur movie makers, made up of juveniles, and known as the "Amateur Movie Producers of America."

The Kearny group, writes Robert E. Johnson, in charge of productions, was organized in May, 1936, since which time they have produced about 15 photoplays and travelogues, the most successful of which has been "Hansel and Gretel." When this was shown in the schools of Kearny it met with instant acclaim—"so much so," writes Mr. Johnson, "that we have a standing offer to come back with all of our new films." One travelogue which required some time was "Newark Airport" and an important newsreel was "The Visit of the King and Queen of England at the New York World's Fair." The most recent films are "Sadie and Mabel Out Camping." "Sadie and Mabel are our great comedy team," Mr. Johnson explains. "They are newspaper people who for four films have been going out on scoops and having lots of adventures." "The Taggs" appear in a

Mr. Johnson directs

Sadle and Mable

family series similar to the Jones or Hardys of Hollywood, their latest film being "Aunt Cora's Visit."

Money received from shows given by the group is put back into the business. Continental is run by a Board of Directors. To assist the Board there is one technical adviser, the only adult, who is technical director and make-up director.

Other member groups of the Amateur Movie Producers of America include: Century Films, Santa Ana, California; Empire Pictures, Chester, Pennsylvania; Modern Films, Stillwater, Oklahoma; Pixilated Pictures, San Antonio, Texas; Skyline Productions, Kansas City, Missouri; United Pictures, Buffalo, New York. The national group's aim is "to further interest in amateur movie producing, to distribute the AMPA-member films and to swap story ideas and films." The group publishes bulletins of information for the member groups as well as a trade paper called "The Floodlight."

American Honors Awards Inaugurated

AWARDING of honors for outstanding American photographers similar to those conferred by the Royal Photographic Society of Great Britain, has been inaugurated by the Photographic Society of America. The awards are made to members of the Society on the basis of distinctive achievement in the various phases of photography. Members do not apply for honors consideration and are not required to submit examples of their work. Furthermore, members may be elected to Fellowships without first having been awarded Associateships.

The first group of recipients of the four classifications of honors, including Honorary Fellow, Honorary Member, Fellow, and Associate, was announced at the October Sixth Annual Convention of the Society in Cleveland. The result of two years of investigation, the Society's first awards included three Honorary Fellowships, conferred upon William H. Jackson, New York City; Dr. C. E. K. Mees, Rochester, N. Y.; and Alfred Stieglitz, New York City; two Honorary Memberships, conferred upon William A. Alcock, Brooklyn, N. Y.; and Louis Fleckenstein, of Long Beach, Calif.; 10 Fellowships and 22 Associateships.

Photo Coloring Contest

PHOTOGRAPHIC contests usually rule out pictures that have been hand colored, so that the latest Raygram contest, just announced, is probably the first of its kind because it specifies that *only* hand colored prints are eligible! The only requirement in the contest, which is unusually broad in scope, is that the print be colored with the Raygram Photo Colors, a new coloring medium recently introduced. It is in the form of processed cotton and is used by twisting it around the end of a stick, moistening in water, and applying to either glossy or matte prints. Entry blanks must accompany prints submitted. If your dealer cannot supply you, write to Contest Editor, Raygram Corporation, 425 Fourth Avenue, New York, New York.

Books on Color

THE recent upsurge of interest in color photography has had its effect on the publication of books on the subject, according to Sydney J. Croan, who is in charge of the book department at Willoughby's in New York City. Mr. Croan knows whereof he speaks because he not only sells books but is an accomplished amateur photographic worker on his own account and is therefore in a position to evaluate the worth of the books he sells.

We asked Mr. Croan to list the color books which, in his opinion, and without reference to sales volume, have the greatest lasting worth. He obliged with the following list, in the order of their importance:

"Color Photography in Practice," by D. A. Spencer.

"Color in Theory & Practice," Vol. I, by Murray and Spencer.

"Color Photography for the Amateur," by Henney and Dudley.

"Natural Color Processes," by Carleton Dunn.

"Photography in Color," by Paul Outerbridge.

"Kodachrome and How to Use It," by Ivan Dmitri.

"Miracle"

THE walls of a particular house were calcimined just before the house was closed for an indefinite period. When the house was reopened, after some lapse of time, it was found that one of the walls had a picture of an outdoor scene upon

it. Investigation revealed that opposite the wall was an old window shade with a very small hole in it, which acted as a pin-hole "camera" to imprint a picture of the outside scene upon the wall. The explanation seemed to be that calcimine becomes darkened when exposed to light. The many times the sun lighted up the outside scene, coupled with the smallness of the pin-hole, evidently was adequate for making the image.

An Atmospheric Bed

We are so accustomed to observing clouds as floating tufts of "cotton" in the sky that it becomes a complete new experience to observe them at a very high altitude. The re-

By infra-red

sult is something like that shown in the illustration, by Mrs. Flora K. Howes of the London Terrace Camera Club (New York City). The cloud banks appear literally to be resting on a "bed" of atmosphere. Mrs. Howes reports that this picture was made looking north from Pike's Peak at an altitude of 14,700 feet. It was shot at 11 o'clock one August morning on Eastman Infra-Red film. With a 6x light red filter, the exposure was *f*/8 at 1/50.

Color Prints

Championing the making of color prints by the man-in-the-street photographer as a practicality of today rather than a possibility of the future, Jack Hevesh, of Fotoshop, Inc., writes us that "any competent amateur photographer, capable of making a good black and white print, can make a good color print" from Kodachrome transparencies.

"One process, for example," he continues, "makes use of the familiar Velour Black emulsion. This process, Defender Chromatone, uses a system of toners identical in manipulation to the sepia, the difference being that instead of sepia, yellow, cyan, and magenta toners are employed. A full natural color print may be made by this process in less than an hour.

"The Curtis Orthtone Process is one in which duplicate prints may be made at will, to the number of 100 or more, from a set of matrices. The matrix making is correlated to the appearance of three black and white Kodabrom prints, made from separation negatives.

"The Carbro process, long considered 'tops' for color rendering, is now available in a Nation Photocolor Kit which includes even a set of bromide prints from which the user can make his first carbro. A Carbro Kit from another manufacturer, Devin McGraw, features manipulation in any darkroom, almost independent of the temperature factor, which for many years made carbro difficult to work."

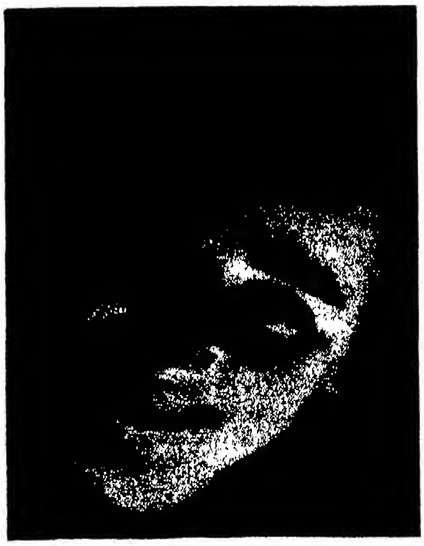
Even separation negatives from your favorite Kodachromes are available ready-made. Fotoshop, Mr. Hevesh reports, does the job at nominal cost.

"Latensification"

A new term for the photographic lexicon, "latensification" was recently introduced by R. A. Cabeen, on behalf of the Du Pont Manufacturing Co., as the latest kink in hypersensitization of film. By the method described, the latent image on the film is intensified after exposure and before development. After the film has been exposed in the camera, the film is removed in the dark and exposed to a safelight for 25 to 40 minutes at a distance of 5 to 10 feet. Mr. Cabeen said that high-speed film can be intensified in this way so that only one half to one fourth normal exposure is required. The treatment may be applied, he said, to all kinds of films, plates, and papers.

Up-Side-Down Pictures

A favorite portrait method with the glamor boys is to shoot the model up-side-down, with the forehead towards the camera and the chin where the forehead normally is, in relation to the camera. This is done by having



Up-side-down

the subject lie down. A spotlight is usually employed for the dramatic effect, although flood lighting may also be used. The result is rather surprising and frequently very flattering to the subject.

Fluorescent Light Ratings

The use of fluorescent daylight-type light calls for a change in the speed rating of Kodachrome, although no change is required when using regular black and white films. According to information issued by the Weston Electrical Instrument Corporation, the Kodachrome ratings when using the Weston Master meters are as follows:

Kodachrome	*Type*	*Rating*
35mm	Regular	Weston 6
35mm	Type A	10
16mm	Reg.	5
16mm	Type A	8
Cut film	Professional Daylight	4

For other than the Master models of the Weston meter, the ratings are, in the order of the above listing, Weston 8, 12, 6, 10 and 5.

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THE ROUND TABLE

Questions Answered for the Amateur Photographer

Q. **Will you suggest a method for adding luster to the surface of a matte or semi-matte print?—A. H. W.**

A. Commercial waxing solutions are available for this purpose, or you can use a mixture in equal parts of olive oil and turpentine. This is applied evenly over the surface with cotton, after which the print is polished with a soft cloth. Another formula is:

Benzol	8 ozs.
Beeswax	1 oz.
Rosin	1/4 oz.
Turpentine	2 ozs.

Pour a little of this solution on the print and then rub it in with cotton. After this treatment, polish it dry with soft cloth or fresh cotton.

Q. **What is a good way to clean old prints?—D. M.**

A. One method that has been successfully used is to apply a thin paste of common starch to the face of the print and, after allowing it to dry for ten minutes, removing the application with running water.

Q. **I have been advised that black spots may be removed from prints simply by scraping them off with the edge of a sharp etching knife. This seems rather difficult. Is there some chemical method?—E. B. L.**

A. With practice, you will not find it difficult to use the etching knife in removing black spots; if too much is cut away, leaving a white spot, this is easily spotted out with a pencil or spotting color at the tip end of an almost dry spotting brush. Chemically, black spots may be reduced by using ink eradicator at the end of a toothpick and touching the spot lightly, removing a little at a time, or with Farmer's Reducer used at half strength. After the application, wash the print thoroughly.

Q. **How can I steady the tripod on a windy day?—J. K. L.**

A. A most effective method is to tie a string around some weight, such as a rock, a log of wood, or anything handy, and the loose end of the string to the tripod screw. This permits the weight to hang between the tripod legs; it will thus reduce vibration of the camera.

Q. **What can be done to "revive" old and stale bromide paper that gives "foggy" results?—N. L. G.**

A. The following method can be used, but the worker is warned that it cuts the speed of the paper by at least 50 percent. Soak the paper for one minute in

Potassium permanganate	5 grains
Sulfuric acid	30 minims
Water to make	50 ounces

Then transfer for a one-minute immersion to

Sodium sulfite	400 grains
Water to make	20 ounces

Rinse the paper and either use it while it is still wet or dry it in the dark.

Q. **How can I remove developer stain caused by using old developer?—J. L. L.**

A. After fixing, wash thoroughly as usual, and immerse in the following solution:

Ferrous sulfate	3 ozs.
Sulfuric acid	1 oz.
Powdered alum	1 oz.
Water to make	20 ozs.

After the stain disappears remove the negative from the solution and wash well.

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WHAT'S NEW

In Photographic Equipment

Kodaflector Senior ($12): Lighting unit for amateur still and movie work. Features reversible reflectors, of sheet aluminum, conical in shape when in use, "unbuttoned" for storing flat, one side bright and polished for narrow beam for use with home-movie camera lenses, other side sand-blasted matte center providing wider beam of less intense but more uniform light. Adapters for both No. 1 and No. 2 Photoflood lamps. Stand consists of two 30-inch telescoping nickel-plated tubes, clamping at various height settings by thumb screw. Outer tube seated in small black lacquered iron casting with sockets for

four 11-inch removable steel rods which form base of unit. Two lamp sockets mounted on L-shaped extension rods at top of Kodaflector Senior stand, adjustable for angle. Available accessory Extra Assembly ($3.75) adding third light to basic two. Kodaflector Senior supplied in suit-case type box of corrugated cardboard, with extra space for lamps, and so on.

INGENTO FILMPACK ADAPTERS ($3 to $3.50): Available in sizes 2¼ by 3¼, 3¼ by 4¼, and 4 by 5 inches. Features new all-metal light trap, precision construction. Hinge type; made of heavy materials for durability. Suitable for Speed Graphic, Watson, Eastman, and Korona cameras.

CELLO-LUME BRUSH ($.15): Cellulose fibers in aluminum tubular handle. Leaves no lint; especially recommended for cleaning photographic lenses.

PRINCETON SENIOR FLUORESCENT ENLARGING LAMP ($24.95): For use in enlargers taking negatives up to 5" by 7". Two-piece construction. Consume 40 watts of electricity. Average life 2000 burning hours. Grid contained in shielded metal housing 5½ by 7½ by 2 inches. Fitted with standard plug. Built-in equalizing screen. Transformer unit separate from light source because large size and heavy construction prohibits inclusion in enlarger lamphouse. Made only for 60 cycles, 110-120 volts, alternating current.

SPEED-EZ-EL PROJECTION EASEL ($.60 to $1.50): Takes ready-cut paper in five standard sizes, 2½ by 3½, 3½ by 5, 4 by 5, 5 by 7, 8 by 10 inches. Focusing directly on easel. All metal construction. Finished in light gray.

KODAK ALL-METAL PRINTER ($16.50): Takes negatives 4 by 5 inches and 3¼ by 5½ inches, with special provision for 35mm negatives in uncut strips, one frame at a time in sequence, on 35mm paper. Print sizes and margin widths (¼ to ¾ inch) adjustable by moving four independent margin masks. Masks of thin spring metal, each with black molded handle; scales provided for margin and print widths. Width and height scales of ruby transparent plastic trans-illuminated by lamps inside printer. Metal platen, hinged. Ruby safelight window in side of printer safelights work table.

BRITELITE UNIVERSALITE LAMP ($57.50): Outfit comprises stand, special focusing device, accessory reflectors. Specifications: lamp housing of aluminum alloy, taking pear-shaped bulbs from No. 4 Photoflood to PS 52—2000-watt movie flood; specially mounted socket on focusing device to center filament; positive acting clutch yoke connecting housing through swiveling device to stand, thus affording 360-degree field of focusing. Universal stand made of aeronautical aluminum in three sections, telescoping to height of 5 feet, with low of 18 inches. Demountable base legs have rubber-tired double-race ball-bearing thread casters. Wiring 20 feet No. 14, rubber-covered heavy-duty cable, with armor-clad plug. Switch mounted in detachable aluminum housing. Outfit weighs 16 pounds.

FRAME-A-CHROME KODACHROME FRAMES ($10 to $20): Available in sizes 4 by 5 inches, 5 by 7 inches, 8 by 10 inches. Consists of 24-karat gold-plate frame to hold enlargements made from 35mm or bantam size Kodachromes, together with shadow box for illumination. Light units alone available ($4.50, $5.50, $7.50).

LEITZ POLARIZING FILTER: Composed of clamping ring fitting over lens, and polarizing filter in rotating mount. Parts joined with pivot. Filter secured to lens through clamping mount. Viewing through filter above camera; filter then swung through 180 degrees to front of lens in same position as when adjusted visually. Filter made in several models: one for use with Leica lenses; special models for Summitar and Leitz Xenon lenses. Adapter available for Rolleiflex and Rolleicord cameras.

CONTRAMETER ($9.95); Exposure meter for enlarging, also serving as automatic paper grade selector, negative comparator, enlarging ratio comparator, integrating photometer. As negative comparator, gives numerical readings of two negatives, showing proportion of difference—for fast routine enlarging. As ratio comparator, registers readings of projected image in two predetermined positions, giving numerical difference as basis of exposure and proportional increase or decrease of light necessary. As integrating photometer, instrument used directly beneath lens for integrated readings.

GOLBLEND TONER ($1 for 2-ounce bottle): One-solution concentrated toner for chloride and chlorobromide developing out papers. Produces wide range of tones with single toning from slight "gold tone" warmth to rich brown without loss of gradation.

ACADEMY BABY SPOTLIGHT ($6.95): Uses 100, 150, or 200-watt T-8 bulb. Equipped with 3-inch Fresnel lens with attached slots for holding diffusion disk or filter. Weight 2¼ pounds. Push-pull adjustment lever facilitates change from spot to flood. Made of chrome-plated rustproof metal; Bahm crinkle finish metal. Used on stand that comes with light, on tripod or lamp standard. Completely ventilated.

YOUR FIREARMS and FISHING TACKLE

Conducted by A. D. RATHBONE, IV

INTEREST IN FIREARMS *is traditional with American men; fishing tackle is a requisite of one of the world's oldest occupations. Scientific development of guns and tackle, in the use of which millions yearly find sport and recreation, fathers this monthly department which welcomes correspondence from readers.*

How to Make a Deer

RIFLE-RANGE shooting is fun, as any gun addict will admit, but a large percentage of run-of-the-woods shooters soon tire of garden variety targets and desire something a bit more exotic than manipulating bullet holes as closely as possible to bulls-eyes. To counteract this ennui on the part of some of its members, and to provide the deer-hunting lads with opportunity for constructive, helpful practice, the Cherokee Rod and Gun Club recently designed, constructed, and now successfully operates a life-size running deer target.

There's nothing new in the idea of moving game targets, but the Cherokees, symbolic of thousands of small groups of American sportsmen in that their treasury is habitually at low ebb, made news by making their own target. Calling on imagination, ingenuity, and a touch of inherent genius enabled them to enjoy one of the features of larger, more affluent organizations. Westchester County, just north of New York City, is the home of Cherokee members and one of the most populous sections in the metropolitan area. When, therefore, we tell you that this little group of sportsmen managed to obtain use of a few acres in this thickly settled region for rifle, pistol, and trap shooting at no cost to themselves, you'll admit that ingenuity was working overtime.

Deer at start of run

As the Cherokee range is a perfect amphitheater in shape, the encircling hills serve as more than adequate safeguards during shooting. This fortunate conformity of terrain also provides a perfect setting for the running deer target, for an end of the cable on which the deer travels is fastened to a stake atop one of the side hills and the other end is secured at the base of the opposite hill. Gravity and a gentle shove do the rest.

Although life-sized lithographed posters of deer are available for pasting on heavy cardboard, the members chose to make their own. Projecting the picture of a running deer onto a sheet of wall board, they traced the outlines, cut out the wall board, and turned it over to an artistic-minded member who did an excellent job of coloring. To facilitate moving, handling, and storing the deer when not in use, they cut him in two vertically and hinged the halves with a glued canvas hinge so that he could be conveniently folded flat.

Deer midway on run. Retouched because of blended background

Using a jig saw, two wooden pulleys were cut through the simple expedient of sawing two circular pieces of wood, six inches in diameter and one with a diameter of five inches. When the smaller was sandwiched between the two larger pieces, the pulley came into existence. To permit the buck to dash down hill on his trolley wire at full speed, they secured an old ball-bearing roller skate, removed two of the wheels and inserted them in the centers of the pulleys in spaces cut to fit. Older skates, by the way, are better for this purpose than are new ones, for the wheels wear in a tapered fashion which makes them fit into the center spaces more snugly.

Meanwhile, the artistic member had inscribed over the heart of the deer a circle marked "10" and concentric arcs both fore and aft of the heart, which were numbered from "9" down to zero, according to the vulnerability of the position. It was discovered that a 400-foot length of ⅛-inch clothesline

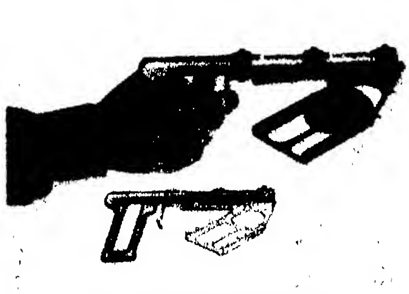
cable would allow the buck an adequate "run," during which hawk-eyed members could see him emerge from behind the shoulder of the starting hill, could fire three carefully aimed shots and, unlike—or should we say comparable to—a live deer, see him disappear behind a clump of trees near the end of the run.

True, because of elevation necessary to provide speed, the deer apparently "flies through the air with the greatest of ease," rather than running along the ground, but the Cherokees, for a total expenditure of $2.95, have provided their members with a target which tests the most skilful shots and at the same time provides maximum safety standards. Working drawings of the Cherokee running deer are available at no cost, if you are interested.

It's Targo, Again

TARGO, that shooting innovation of the Mossbergs (August, 1940), has an accessory in the form of a hand-gun-trap for releasing the miniature clay targets. The Targo trap is easily removed from the barrel of the Targo rifle and screwed to the hand-gun frame, thus permitting targets to be released by another person without advance knowledge on the part of the shooter of the general direction of the target's flight. The frame of the hand-gun-trap weighs but a few ounces, costs less than a dollar by itself, is conveniently carried in a hip pocket. Unlike ordinary hand-traps for clay targets, the Targo trap operates with a simple pull of the trigger and no motion of the arm is necessary.

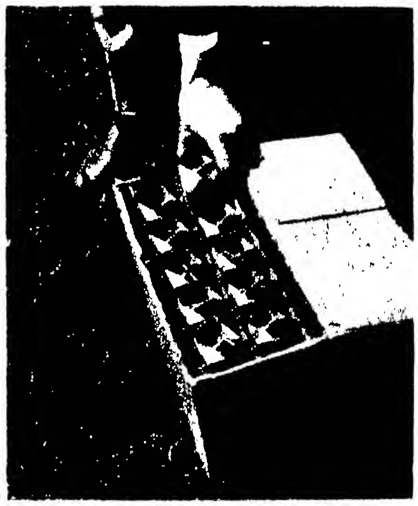
Targo is not a "cinch." It will test the skill of the best shooters, yet will provide good fun and excellent training for the novice at unbelievably low cost. To assist both beginners and old hands at the sport of smashing flying clay targets, the Mossbergs plan to publish a special booklet on how to shoot Targo. Study has shown that some shooters fail to shoulder and cheek the gun properly, which means they under or over shoot, mostly the



Targo hand-gun-trap

latter. Others do not shoot quickly enough, but ride the target out beyond the effective range of the .22 shot cartridge. Naturally, the tiny pellets of the .22 do not carry as far nor do they pattern as extensively as those of a .410 bore or larger gun, so shooting must be done faster and the target must be centered more closely in Targo, which means that gunners who master miniature target shooting have prepared themselves to become good skeet and field shots by learning the fundamentals of timing and co-ordination.

Conclusive evidence of Targo's popularity is found in the fact that several million of the little targets have been shipped to all parts of the country. Due to Mossberg's special packaging process, more or less a modern miracle, these fragile little flyers arrive safely and unbroken. Not one com-



Unique packaging of targets; insurance against breakage

plaint of breakage has been received at the factory. We still have some circulars describing the game of Targo and can also arrange to send you one of the new instruction booklets when it is printed. Want 'em?

Fish Cost Money

IF WIVES of fishermen realized that their angling husbands pay from 15 to 20 times as much per pound for the trout or bass proudly brought home as the ladies do for fish they buy in the neighborhood markets—well, you figure out the answer and be guided accordingly. One authority estimates that 12 million sports-fishermen spend $1,200,000,000 annually for the dual privilege of wetting lines and hoping the fish will bite. This figure breaks down into 10 millions for licenses, 35 millions for tackle and equipment, and the balance for transportation, sleeping accommodations, food, gasoline, boats, guides, clothing, tents, blankets, outdoor paraphernalia, and miscellaneous items of all kinds.

Despite the fact that these figures sound more like planetary distances than out-of-pocket expenses for the country's army of Izaak Waltons, the United States Bureau of Fisheries offers statistics to match. The Bureau boasts an annual production of eight billion fish and eggs, of which seven billion are commercial species against one billion of so-called game fishes.

At first glance these figures would seem to indicate that the men who make angling a business are getting by far the best of it. "However," says the Bureau, "the actual facts are these. Commercial species, with the exception of lobsters, are all planted in the fry stages, are not fed in our hatcheries, and in most cases are planted when only a few days old. The cost of production, therefore, is insignificant when compared with that of game fish which are distributed as fingerlings, in 6 to 9-inch sizes, a factor necessitating more expensive feeding, larger water areas, and of course, a longer period of retention in the rearing units."

If you think we've been dealing in higher mathematics thus far, beware of the following. The Bureau states the cost of producing commercial fishes averages $21 per million, whereas game species average $6146 per million, and that, fellow anglers, is equivalent to .000021 per commercial fish against .006146 per game fish —and the latter are still separated from the angler's creel by the price of a license and the cost of the fisherman's equipment. (We refuse to consider the value of his time!) So, when next you're tempted to keep that little trout, remember that under the comparison of what you and your wife pay for fish, you are contemplating about a dollar's worth of fish. If you put him back and let him live, he might grow big enough to be worth at least a couple of bucks!

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POT SHOTS

At Things New

South Bend Bait Company recently permitted us to pre-view their Trade Catalog No. 91, effective for the 1941 fishing season, and we're prepared to state it is one of the most complete and fascinating angler's tackle encyclopedias we've seen. This Trade Catalog, you understand, is the one that guides your hardware and sporting goods dealer. The customary catalog for the individual angler will be issued a little later, and we've been assured that it, too, will depict every fishing need, including many new and intriguing items. If, in happy anticipation of piscatorial battles to come, you would like to pore over the pages of South Bend's newest publication for angling customers while winter winds blow and lakes and streams are ice-bound, send us your name and address and we'll arrange to have a catalog sent to you as soon as they're off the press.

Marlin Firearms Company believes there is an unmistakable trend toward the over/under type of shotguns and cites as proof their own strenuously successful efforts to keep abreast of orders. They have prepared for further growth of demand for o./u. guns by making their famous Model 90 in .410 bore, in 12, 16 and 20 gages, in three types of rifle-shotgun combinations, and in the custom-made "Skeetking."

When the Model 90 was developed for a combination of .22-caliber rifle and .410-bore shotgun barrels, Marlin frankly admits it was in the nature of an experiment. Neither production nor sales officials looked for any spontaneous demand, while some of the old-timers at the Marlin plant regarded the new creation as a freak. The $40 price alone was viewed as a reason why sales couldn't be very great shakes, yet it was not feasible to produce a real firearm of rugged construction to sell in a lower price range.

However, almost from the introduction of the over/under rifle-shotgun combination the factory had to step up production to satisfy the demand. When the .410 bore shotgun barrel was offered in combination with the high velocity .218 Bee and .22 Hornet barrels, capacity to turn out these particular models was severely taxed within a few months. The combination guns have proved to be the answer to many a hunter's prayer—the .22 long-rifle high-speed barrel for his longer shots, the .410 bore 3-inch shot shell for closer shots, and a .410 bore slug for his larger game.

Delta Electric Company, in anticipation of pleasurable excitement to be derived from after-dark angling by thousands of fishermen who have never tried the sport between sunset and sunrise, have issued a 70-page booklet entitled "Night Fishing." It was written by Cal Johnson, one of the ace Waltonians of America and Angling Editor of *Sports Afield* magazine. Delta Electric's "Powerlite" electric lanterns, as well known as they are indispensable to fishermen, hunters and campers, are also fully described. But Cal Johnson's suggestions on where, how, and when to fish at night make mighty good winter reading preparatory to the opening of next year's fishing seasons. Want a copy?

The National Wildlife Federation's chart of 30 common fresh water fish, accurately lithographed as to natural color, proportion, and ichtyology, from paintings prepared by Andrew Jansen, has proved a useful, instructive reference for anglers, conservationists, schools, and colleges. The chart measures 26 by 40 inches, includes, among others, the golden shiner, muskalonge, pike, eastern pickerel, wall-eye pike, large and small-mouth black bass, lake, brook, brown and rainbow trout, with explanations and descriptions prepared by the United States Bureau of Fisheries printed below each fish. The charts, framed or unframed, are obtainable only from The National Wildlife Federation, sponsors of National Wildlife Restoration Week, nationally observed in the early part of each year.

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with a list of available titles, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for.

OUR TREMBLING EARTH

By Joseph S. Lynch, S. J.

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By H. B. Webb

NOT to be confused with the well-known, earlier, and no longer available atlas entitled "Webb's Celestial Objects for Common Telescopes," is this entirely new one by another and an unrelated Webb—the widely known variable star observer and member of the Chart Committee of the A. A. V. S. O. It is nothing like a beginner's wonder-book atlas but is adapted to amateurs who have had a little experience, mainly with telescopes equipped with setting circles. It covers an area from the North Pole to 23° S. Dec. First, this total area is broken into nine large-scale finder charts, and these in turn are keyed, by means of massive numbers for better visibility in dim light, to 126 full-page detail charts showing coördinates. The detail charts indi-

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Edited by Thomas O. Sheckell

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PRACTICAL MATHEMATICS
By Glenn M. Hobbs, James McKinney, Revised by J. Ralph Dalzell

Crutch books on mathematics, for "helping lame ducks over stiles," are always perfectly lucid—to other mathematicians. But many of them still are too sketchy. This one, on elementary mathematics, seems more sympathetic than most, and almost takes the lonely, bogged-down sufferer by the hand to encourage him along—something which most mathematicians refuse to do, usually because, themselves being equipped with first-class intellects, they apparently can't believe anyone should really have these troubles. This book

is mainly on arithmetic, but includes logarithms, a touch of simple algebra, and those parts of geometry likely to have practical value. (If your youngster is having trouble, or if you are having trouble with the forgotten mathematics you are trying to recall well enough to help your youngster out, this book, secretly run over after he is in bed, might save your reputation.) A good book. (597 pages, 5¼ by 8¼ inches, illustrated.)—$2.50 postpaid.—*A. G. I.*

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A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

There never has been a perfect telescope. Can't be made. Can't even be designed. Design of any telescope involves making compromises with several cramping factors, or devils, yclept aberrations and coma, which science knows no way to wipe out entirely. Farthest, however, in that direction are the aplanatic family—the Schmidts, the Schwarzschilds, the Ritchey-Chrétiens, and the Wrights. Frankly, these telescopes (usually used photographically) aren't tyro work, but the average amateur telescope maker, being everlastingly ambitious, secretly harbors the intention of tackling one as soon as he has proved his steel on a few ordinary reflectors and a refractor. A number have done this already, and with success. This month we have items regarding aplanatics, from two amateurs who became professionals, respectively as optician, astronomer.

Schmidt wide-field camera-telescopes heretofore could not be used visually. Moreover, their adjustment has been a bugbear, requiring the patience of Job, because it had to be done photographically and piecemeal. In the following item, contributed by Russell W. Porter, these bugbears disappear: it describes a new Schmidt that may be used either visually or photographically.

"Dr. John Anderson," the executive officer in charge of the 200" telescope project, "has suggested a modification of the Schmidt camera," Porter writes, "which is shown in Figure 1. He thinks that this type, which includes the Schmidt principle, may appeal to amateur telescope makers, in that, by the additional reflecting surface, the focus of the camera is brought out into the open where it can be more easily collimated. Moreover, with the focus outside the camera box, the instrument may be used visually as a telescope.

"If an $f/3$ ratio is adopted, and the aperture is 8", then the two mirrors will be of 12" diameter, and the focal length of the instrument 24". Eyepieces of any *e.f.l.* may be used.

"By jack-knifing a Schmidt, as shown, it is set at 60°, which is about the angle required to prevent light that enters the correcting plate from striking the photographic film.

"The camera box could be put together with ¼" and ½" plywood, the corners reinforced with small angle irons. It may be mounted in a fork and used as an alt-azimuth or equatorial.

"The cells of all the optical parts should have push-pull screws for adjustment."

First to make the aplanatic reflector proposed in "Amateur Telescope Making—Advanced" by Franklin B. Wright, and by him modestly called the "short" telescope, though the name "Wright" telescope is suggested now, instead, is Robert T. Smith, night assistant at the Lick Observatory, Mt. Hamilton, California. Smith took astronomy at the University of California, made telescopes as an amateur (6" Newtonian, 6" Cassegrainian, 4" semi-RFT), then lost his pure amateur status by working at the Tinsley Laboratories where he made 200 eyepieces. For the past year he has been at Lick, where he wrestles with the large telescopes at night, and on his own time has worked on his Wright telescope in the basement of the dormitory where the astronomers sleep. "My little telescopes look insignificant," he says, "beside the big instruments I work with every night, but I still have TN blood in my veins and intend to push pieces of glass for some time to come." Smith's description follows:

"I have just completed an 8", $f/4$, flatfield 'short' telescope (Figure 2), as described by Mr. Franklin B. Wright in 'ATMA'. As far as Mr. Wright and I know, it is the first one to be completed to his specifications. Mr. Wright himself has one of a slightly modified form very nearly completed, the optical parts of which were made by Mr. Carl Wells, of Roseville, California. Mr. Wells had completed the oblate spheroidal mirror before I started mine, and I am indebted to him for several hints on the figuring of such a curve.

"About 60 or 70 hours were spent on the 10", $f/3.2$, Pyrex oblate spheroid for this telescope. A micrometer-screw knife-edge tester was made that reads to thousandths of an inch. Diaphram openings 0.4" wide and 1" high were used for zonal testing — the smallest zone easily observed with the naked eye according to Gaviola and Platzeck (*Journal of the Optical Society of America,* Nov. 1939). The diaphram openings were spaced 0.4" apart and two alternate diaphrams were used, so that the whole surface was tested.

"The oblate spheroid is a very difficult figure to achieve. Since it is a fourth degree curve, the slope becomes rapidly steeper as you go from center to edge, and such a curve is extremely difficult to figure with a full-sized solid (pitch) lap. One's first thought is that an inverted, rose convexing lap would produce the required curve, but, although it does produce the necessary high center, the slope is greatest at the center instead of at the edge. In figuring the oblate spheroid I first obtained the high center with a full diameter inverted rose with six petals removed. I then proceeded with laps ranging from 1" to 4" in diameter, all circular (that is, no star or rose-petaled shapes). These were all worked with tangential strokes with the mirror face up, with care that an even number of revolutions were made around the mirror. If zones began to appear they were smoothed off with the 4" lap stroked radially, or at right angles to the zone. Although this local figuring has a tendency to produce ring zones, no great trouble is experienced if one proceeds slowly and cautiously. The mirror was figured until all zones approximated the error of observation.

"The correcting lens (Figure 3) was made of Pittsburgh's Crystalex or 'Water Clear Plate,' 17/64" thick and 9" in diameter (the 9" being dia-

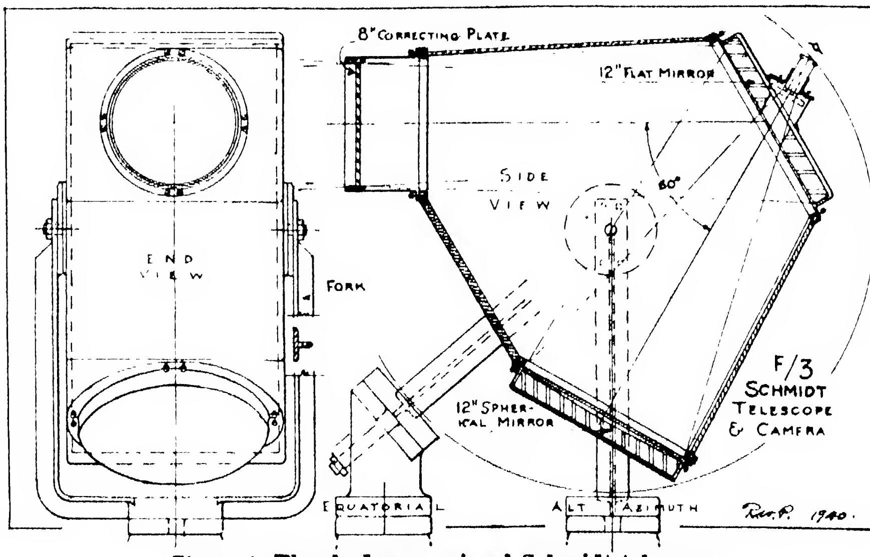


Figure 1: **The Anderson, visual Schmidt telescope**

phramed to 8" in the camera, which is the usual practice with Schmidt correcting lenses). The index of refraction was determined to be 1.515 by measuring the difference in focus of a microscope with and without the glass. Both surfaces were tested against a sphere for flatness, and one surface was found to be flat within one wave, so I decided to work only one surface. It might be argued that one wave is not flat enough, but I may

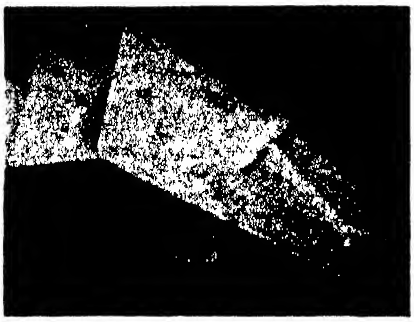


Figure 2: **Smith's Wright camera**

explain that the deviation from flat, curiously, was concentric with the edge and amounted to a uniform concavity of one wave or less, so that, as long as the correction on the other side was figured to take care of this, no harmful results could be expected. The side on which the correction was put had ridges several waves high, slightly curved, about ½" wide and about ½" apart. These were apparent as dark bands across the lens when the lens was viewed in front of the mirror under test, when the knife-edge was parallel to the ridges. They undoubtedly were due to the large circular polisher used at the factory for polishing the glass after it is

Figure 3: **Corrector, spider**

rolled, and they might well be looked out for. The glass was checked for striae and strains under polarized light and none was found, so work proceeded.

"Grinding and polishing were both done on mobile laps made of sponge rubber cut from ordinary kneeling pads. The grinding facets were cut from projection slide cover glass 1/16" thick, and were fastened to the rubber base with Goodrich Running Board Matting Cement, which proved very

satisfactory and is recommended. The polishing laps went merely one step further, in that HCF squares were cemented to the glass facets. I have now given myself away in the mention of HCF, and must admit that it was used entirely for polishing and figuring both the mirror and the correcting lens. I realize that HCF is not approved of in the best circles

Figure 4: **The plate holder**

[for final figuring.—*Ed.*], and I freely admit that it does not produce the satin-smooth surface that pitch does. But it does work glass faster and is much easier to handle. Therefore, since the tolerances in a photographic instrument are greater than in a visual, and because I am fundamentally lazy, I was induced to use HCF.

"The grinding of the correcting lens was done with American Optical's emery, a finer grind than usual being desirable in order to facilitate testing while still in the fine-ground stage. I found that the ring lap usually recommended for correcting lenses produced one deep zone rather than the necessary curvature. So the ring, which was of 1" square facets, was modified with ½" square facets placed by trial and error until the correction moved in the right direction. The first attempt at correction was made with M302, but this took away far too much glass and the surface had to be brought back to flat by grinding on a flat piece of plate glass. The correct depth of curve was roughly reached with M303½ and was smoothed off with M304 and M305. With a surface finished with M305 a Ronchi test can be made through the lens placed in front of the mirror. Five minutes' polishing was sufficient to make a rough zonal knife-edge test to determine the approximate extent of the correction. The same diaphrams were used that served to test the mirror.

"The lens was brought to a polish with a full lap of 1" squares of HCF, with the lens face up and the lap on top, and with no backing to the sponge rubber. A lap with the rubber base cemented to a wooden backing tended to polish some parts more than others. The unbacked lap seemed better able to conform to the curvature without changing the correction. The final figure was obtained with small laps used in the same manner as on the mirror. However, these laps were mounted on rubber the same as the full diameter lap. The last two hours were spent in polishing with the tip of my index finger, since the zones to be corrected were so narrow.

"One curious thing was noticed in testing the correcting lens. Although the difference in radii between zones was the same for all diameters, the whole set of readings fluctuated up to ten-thousandths of an inch for different diameters. That is, the readings for one diameter varied up to ten-thousandths from those of any other diameter, although the difference between zones was right. Just what this fluctuation for different diameters really means regarding the shape of the lens, I don't know, but apparently it should be avoided, since it does have a small effect on some of the images. The effect on the images, fortunately, is not troublesome and is explained in a later paragraph.

"The appearance of the mirror under test is that of a paraboloid turned inside out, and because of the 3.2 focal ratio the shadows are very pronounced. A Ronchi test shows the grid to be 'knock-kneed' in contrast to the parabolic bowing, rather gently curved near the center and the curvature becoming more pronounced as the edge is approached. With the correcting lens placed in front of the mirror, the appearance is almost exactly reversed. The knife-edge shows the familiar parabolic dough-nut, although it is not quite the usual form, and the Ronchi grid is bowed, gently near the center and strongly at the edge. All the tests on the correcting lens were zonal tests of radii of curvature, the readings being calculated from the formula on page 409 of 'ATMA.' I am indebted to Mr. Wright for his counsel and advice during the figuring of the mirror and lens. He was most helpful in converting his theory into actual practice. One should be thoroughly familiar with the theory behind this camera before attempting one, and he was most patient in explaining its details to me.

"The two optical parts are now mounted in a square wooden tube made of ¾" five-ply wood, 13" wide and 44" long. The mirror is mounted in a machined brass cell held to the end plate of the tube with three clamp and three butt screws, which serve also as collimating screws. The correcting lens is mounted in a cell of plywood. The plate holder (Figure 4) clamps to one end of a piece of 3" brass tubing, 2" from the back of the lens (Figure 3). Focusing is done by means of the collimating screws that hold the lens cell in the tube. Thus, in focusing, both the correcting lens and plate move together. In the middle of the main tube, between the plate and the mirror, is a diaphram, in front of which is a hinged flap used for opening and closing the exposure. A trap door in the side allows one to reach the plate holder. The plate holder was made especially for the camera, and takes glass plates

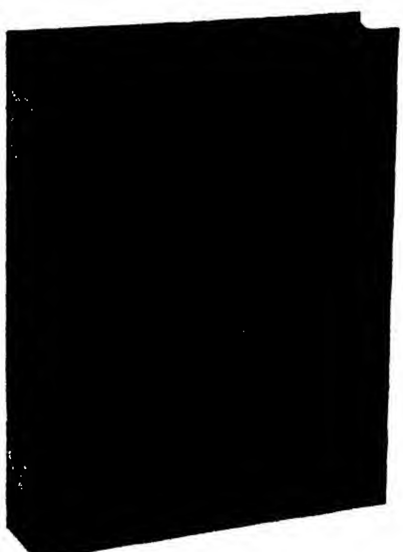
Figure 5: **Good images, 4.2° field**

$2\frac{1}{2}''$ square. The exposed area is circular and $2\frac{3}{8}''$ in diameter, which is just over 4°.

"Collimation of the two optical parts cannot be stressed too strongly. The most important thing is to have the optical axis of the mirror pass precisely through the optical center of the correcting lens. I did not realize this until after I had taken innumerable plates and found plus sign images instead of round dots. I tried all manner of means to cure the plus sign images but with no results. I finally talked it over with Mr. Wright and he suggested that the collimation be adjusted even more accurately than I had done. I did, and found that the plus sign images disappeared over most of the plate, but remained to a slight degree in two small areas diametrically opposite on the plate. By rotating the correcting lens in its cell the two small areas are found to rotate by an equal amount. This apparently means that the correcting lens is possibly not a true figure of revolution, or that the unfigured surface is slightly cylindrical in shape. There is probably some connection between the fluctuations noticed in testing the lens and the two small areas of plus sign images. However, this condition does not seriously affect the performance of the camera, since the plus sign images are burned out with normal exposure. Accordingly, there seems to be no necessity for refiguring the lens. The images (Figure 5) produced by the Wright camera are very good over a 4.2° field after the collimation, focus and tilt of the plate are accurately adjusted, and have been pronounced satisfactory for photometric work, which requires extremely good images.

"I have mounted the camera on the Crocker telescope here at the Lick Observatory in order to try out its performance. The Crocker telescope is in a 10′ dome and consists of a mounting with a large flat plate at the end of the declination axis, to which moderate sized cameras can be bolted. The clock is weight driven and the guiding telescope is a $6\frac{1}{2}''$ refractor with illuminated cross wires.

"I would be very glad to correspond with anyone who is interested in making a Wright camera."



LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., L.L.B., Sc.D.
New York Bar
Editor, Scientific American

Interpretation

IF A recording of an orchestra leader's interpretation of a musical composition is sold with the consent of the orchestra leader, he has surrendered his property right to the particular interpretation and no valid restriction can be placed on the use of the recording, according to a recent decision of a Federal Circuit Court of Appeals. This decision reversed the decision of a lower court which was discussed on this page in the February 1940 issue of Scientific American.

The facts involved in the case were as follows:

A record manufacturer made recordings of a prominent leader's interpretation of musical compositions and the recordings were sold to the public with a notice affixed thereto stating that they were to be used "only for non-commercial use on phonographs in homes." A radio broadcasting station purchased some of the recordings and in spite of the notice appearing thereon, broadcast the recordings over the radio. The record manufacturer brought suit against the radio broadcaster to restrain further broadcasting of the recordings and the trial court granted an injunction. In granting the injunction, the trial court held that the orchestra leader had a property right in his interpretations of the musical compositions, that he had transferred the property right to the record manufacturer, and that the manufacturer as the owner of this property right could control the use which was made of the recordings.

When the case was reviewed by the Circuit Court of Appeals, the decision of the trial court was reversed on the traditional principle of American law that literary property rights are destroyed when they are published without copyright or other statutory protection. The Court of Appeals pointed out that the recordings were sold with the knowledge and consent of the orchestra leader without copyright protection for the orchestra leader's interpretation. The sale of the recordings constituted a publication which destroyed any property right existing in the orchestra leader's interpretation. Since this property right was destroyed, no valid restriction could be placed on the use which was thereafter made of the recordings.

This decision is of importance because it is in direct conflict with the decision of the highest court of the State of Pennsylvania. The principles involved are of great importance to the musical industry generally and for this reason it is probable that an attempt will be made to obtain a review by the United States Supreme Court.

Fashion Boycott

THE acts of an association of dress manufacturers formed to protect members against piracy of original designs were held to constitute an illegal boycott in restraint of trade.

For many years the piracy of designs in the textile and garment industry has presented a serious problem. To combat this evil, a group of dress manufacturers formed an association and agreed among themselves that they would refuse to sell dresses to retailers who purchased or induced the manufacture of dresses which the association considered to be copies of the designs of its members. The association employed shoppers who visited retail stores in various parts of the country to determine whether they were selling infringing designs and also established a so-called "piracy committee" which acted as judges to decide whether any of the dresses complained of by association members embodied infringing designs.

The Federal Trade Commission charged that the agreement among its members to refuse to sell dresses to any retailer selling copies constituted an illegal boycott in restraint of trade. The Commission ordered the association to cease and desist the practices complained of and the association then applied to a Federal Court of Appeals to review the order. The Federal Court affirmed the order of the Federal Trade Commission, stating that a boycott is prima facie illegal and it must be justified by the persons practicing the boycott. The court pointed out that the members of the association would have the right to refuse to sell to retailers who bought dresses from manufacturers who had stolen unpublished designs or who had gained access to the designs through a criminal act. However, in the present instance, the boycott extended far beyond an attempt to suppress illegal or criminal acts. Under our law, anyone has the right to copy the design of a dress

which has been published or sold in the absence of patent protection. Since it was legal to copy the published designs of members of the association, the Court ruled that the association could not resort to a boycott in restraint of trade in attempting to suppress the copying.

Pyrex

The manufacturer of the well-known heat-resisting glass may still continue to designate his products by the trade mark "Pyrex." The right of the manufacturer to use the trade mark "Pyrex" was challenged in a recent suit brought by a competing manufacturer who owned the trade mark "Rex."

The competing manufacturer, who was the plaintiff in the suit, had used the trade mark "Rex" from the year 1896 to designate glass prescription bottles which were sold primarily to the pharmaceutical trade. The defendant in the suit adopted the trade mark "Pyrex" in 1915 as a trade mark for products made from the heat-resisting glass which it had developed. Originally the mark was applied to heating equipment and cooking utensils, but in the year 1922 the defendant started to make nursing bottles for infants and designated them by the trade mark "Pyrex."

Up to the year 1928 the plaintiff and defendant were not selling directly competing articles under the trade marks "Rex" and "Pyrex" respectively. However, in the year 1928 the plaintiff began to manufacture nursing bottles under the trade mark "Rex." These nursing bottles were made of ordinary glass and were much less expensive than the bottles made from Pyrex glass. Finally, the owner of the trade mark "Rex" brought suit against the owner of the trade mark "Pyrex," claiming that the trade marks were confusingly similar to each other and that they were used on goods of the same descriptive properties.

The Trial Court sustained the contention of the plaintiff and ordered an injunction restraining the further use of the trade mark "Pyrex." An appeal was taken to the Circuit Court of Appeals and the decision of the Trial Court was reversed. The Circuit Court of Appeals held that there was no trade mark infringement, and accordingly refused to grant an injunction.

In reaching its conclusion the Circuit Court of Appeals pointed out that a great deal of time had passed since the defendant adopted the trade mark "Pyrex," that "Pyrex" was different in sound and appearance from "Rex," that the only directly competing merchandise upon which both marks were used was infants' nursing bottles and that on this product the defendant used its trade mark "Pyrex" before the plaintiff used its trade mark "Rex."

(The Editor will appreciate it if you will mention 'Scientific American when writing for any of the publications listed below.)

DUPONT MINIATURE CAMERA FILMS is an 18-page pocket-size booklet describing 35mm film for all kinds of amateur and professional photography, including two special-purpose films—Infra D and Microcopy. Infra D is sensitive to infra-red and Microcopy is an ultra-fine grain film of high contrast. Included in the booklet are processing formulas, filter factor tables, and other data. *Du Pont Film Manufacturing Corp., Inc., 9 Rockefeller Plaza, New York, New York.—Gratis.*

THE AMERICAN LINE is an illustrated catalog of modern foundry equipment. Also presented are operating views of typical installations in industrial plants. Request catalog No. 60. *The American Foundry Equipment Co., 574 S. Byrkit Street, Mishawaka, Indiana.—Gratis.*

FOREST OUTINGS is a 311-page book by 30 foresters, discussing in a friendly, informal manner a wide variety of aspects of the national forests and parks, such as camps, winter sports, timber, fires, game, miners, primitive areas. A book to make people want to understand the forests by revealing their attractions in a partly informative, partly romantic way. A folding map of the national parks and forests is included. *Superintendent of Documents, Washington, D. C.—75 cents.*

THE USE OF THE RESPIRATOR IN POLIOMYELITIS explains the proper use of the "iron lung," with surrounding facts about this type of treatment of infantile paralysis. *The National Foundation for Infantile Paralysis. 120 Broadway, New York.—Gratis.*

DOMESTIC PRODUCTION OF ESSENTIAL OILS FROM AROMATIC PLANTS is a compilation of research papers on six new varieties of plants—coriander, caraway, fennel, angelica, licorice, anise—which could be introduced into this country with a promise of high profit. Growing and extraction of the oils are covered. *National Farm Chemurgic Council, 50 W. Broad St., Columbus, Ohio.—50 cents.*

THE TENDERIZATION OF MEAT is a 6-page pamphlet that describes the Tenderay ultra-violet and heat treatment. *Industrial Fellowship on Meat Merchandising, Mellon Institute. Pittsburgh, Pennsylvania.—Gratis.*

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION, 1939. This uninviting title conceals the fact that, buried behind the 20 percent of this annual which actually is a stuffy "annual report" is a 400-page appendix which is the tail that wags the dog: a collection of the year's outstanding articles on all branches of science, easily the equal of a science best seller but sold at cost because government printed. Readers of scientific leaning should get the annual habit. *Superintendent of Documents, Washington, D. C.—$1.50.*

HURRICANE FLOODS OF SEPTEMBER 1938 is an immense, 562-page, detailed compilation of authentic, United States Geological Survey data on the precipitation, stream discharge, sea wave crest level, and Long Island ground-water recharge, pertaining to the great flood of '38, illustrated with photographs, charts, maps. *Superintendent of Documents, Washington, D. C.—$1.25.*

LAFAYETTE CAMERA CATALOG NO. 81R contains listing of complete stock of cameras, enlargers, film, printing paper, chemicals, and many new photographic accessories. Printed in gravure. *Lafayette Camera Division of Radio Wire Television, Inc., 100 Sixth Avenue, New York, New York.—Gratis.*

THE STORY OF PHILCO PROGRESS is a 14-page booklet that delineates the growth of this organization from its parent company in 1892. A record of achievement. *Philco Corporation, Tioga and C Streets, Philadelphia, Pennsylvania.—Gratis.*

DON'T PLANT GOOD SEEDS is a 32-page booklet that shows the disappointments that a gardener will encounter if he plants seeds in soil unfitted to the growth of the plant. It then goes on to show how to condition soil so as to obtain the best possible results. *Sudbury Soil Testing Laboratory, South Sudbury, Massachusetts.—Gratis.*

ILLYNE'S STAR CHART, measuring 30 inches square, is a naked-eye chart for learning the skies. It and the 24-page booklet in which it is folded include four special charts, one of the South Polar region, also tables and explanatory matter. *Weems System of Navigation, Annapolis, Maryland.—$1.00.*

PHOTO RELAYS, THEIR THEORY AND APPLICATION, by F. H. Shepard, Jr., is a 28-page pamphlet that describes the photo-electric phenomena, amplifiers for photo-electric circuits, other equipment used in this work, and applications of photo-electric cells to a wide variety of duties. *Allied Control Company, Inc., 227 Fulton Street, New York, New York.—25 cents.*

THE OZALID FAST-PRINTING MODEL "F" WHITEPRINT MACHINE is a large folded sheet that describes equipment for producing whiteprints in quantity. The folder shows the details of this new model and shows how it can be used to provide short cuts in drafting rooms. *Ozalid Corporation, Johnson City, New York.—Gratis.*

Printed in the U. S. A. Press of the Wilson H. Lee Company, Orange, Connecticut

NEARLY 50 merchant vessels were put into service during 1939 and 1940, comprising the nucleus of the new U. S. Merchant Fleet. Built to recapture the "cream" of international trade, this new fleet will be composed of vessels that are efficient, economical, and safe. The story of this work, and its significance to our national defense, is told on page 86.

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SCIENTIFIC AMERICAN

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NINETY-SEVENTH YEAR • ORSON D. MUNN, Editor

FEBRUARY • 1941

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50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of February, 1891)

WIRED MUSIC—"One of the interesting developments of telephone work is that which is now steadily going on —the transmission of orchestral music over long distances. . . . This work has been carried on by the American Telephone and Telegraph Company, known as the 'Long Distance Company.'. . . In a lecture recently delivered in the Town Hall at Newton, Mass., Mr. Pickernell described the methods employed in the transmission of music by telephone. His remarks were very forcibly illustrated by the reception in the lecture hall of music transmitted over the long distance lines from the telephone building, at No. 18 Cortlandt Street, New York, and our engraving, made from a photograph taken at the time, shows the arrangement of the performers. . . By using separate transmitters for each instrument, due prominence may be given to each of the instruments at the receiving end. . . At the receiving station, when it is desired to fill halls of considerable size, as many as six loud-speaking receivers are used."

CHIMNEYS—"There is no doubt but the form of a roof has much to do with the draught of a chimney. The flat roof offers no resistance to the passage of air, but as the pitch is increased, the current is more and more disturbed, until with a high-pitched and many-gabled roof it is broken into innumerable eddies, some of which are sure to curl down and force the smoke and gases in the flue into the rooms below. Chimneys on such roofs should be built higher than ordinarily."

FALL RIVER LINE—"The *Puritan* is the most successful achievement of the Fall River Line and is the largest and finest vessel of the fleet. . . Her total displacement, ready for a trip, is 4,150 tons, and her gross tonnage is 4,650 tons. The Puritan is fireproof and unsinkable. She has a double hull, is divided into 59 water-tight compartments, 52 between the hulls and 7 athwartship bulkheads. . . Her wheels are of steel, and are 35 feet in diameter outside the buckets."

RAILROAD TIES—"The annual consumption of railroad ties is placed at 73,000,000, which requires 365,000,000 cu. ft. of raw material. The destructive effects upon forests of the present demand for tie timber is shown by the fact that this material is now largely cut from trees that will make only one tie, or, at least, only one tie from a cut."

FINGERPRINTS—"At a recent meeting of the Anthropological Institute, Mr. Francis Galton, F.R.S., exhibited a large number of impressions of the bulbs of the thumb and fingers of human hands, showing the curves of the capillary ridges on the skin. These impressions are an unfailing mark of the identity of a person, since they do not vary from youth to age, and are different in different individuals."

TRANS-SIBERIA—"The great Siberian railway, which will more closely connect Europe with the teeming millions of China, Japan, and Eastern Asia, will be commenced this spring. The total length of the line will be 4,810 miles, and the cost about thirty-two millions sterling. . . . It will not only help to open out the immense resources of southern Siberia, but will enable Russia to compete more successfully for the Japanese and Chinese carrying and import trade."

TIN PLATE—"The manufacture of tin plate has been commenced in this country, and has come to stay. . . The consumption of tin in this country is enormous, and it will require many gigantic establishments to supply the demand. The world's production of tin plate is 562,000 tons per annum, of which the United States require 369,000 tons nearly all of which at present comes from England."

SHIPPING—"It seems certain now that the winter will be a dull one in the shipping trade. . . The only vessels that seem to be doing any good at all are the newest and largest class of steamers supplied with the latest improvements of triple expansion engines. These are enabled to take large cargoes and make quick voyages as a rule, and, as they are said to save about 15 percent in the cost of fuel, there is no wonder that they can be kept working while others are altogether unemployed."

ROPE—"The wire rope made by the Washburn Iron Manufacturing Company, Worcester, Mass., in 1890, for the Denver Tramway Company, Denver, Col., is six miles long, and is made of crucible steel wire."

MILITARY SMOKE—"Smokeless powder and the results of its use in the battles of the future are being much discussed by military men. An enemy not concealed behind works will, there is reason to believe, be under considerable disadvantage with no smoke to cover him. . . With the advance of cavalry not covered by the smoke of infantry fire till at least near to striking distance, the quick-fire gun is likely to do some terrible work, if not to make such cavalry advances altogether impracticable. Troops operating in the smoke of their own guns can often see across a field to the enemy while he cannot see them."

GERIATRICS—"Old age has its special dangers and its special safety with regard to disease. For instance, whereas in a child the temperature goes up on the slightest provocation, in old age it can hardly be moved at all. The aged body is not, as a rule, prone to any acute disease. If a person passes eighty, it is rare for him to be seized with any special malady. . . There is, on the other hand, a tendency in old age for slight diseases to become chronic."

OUR Point OF VIEW

BRITAIN, OUR LABORATORY

"MOST people don't seem to realize how much we are getting from the war in the form of secret and technical information that will aid us in our own armament effort." So said an American general recently upon his arrival home from an observational trip to England.

Passing over the obvious fact that we are saving our own skins by aiding Britain, let us emphasize here the general's remarks: We are learning much and saving ourselves millions in money. Consider airplanes, for example. Were it not for Britain's use of our military planes—pretty much under our observation, of course—these machines, in simple Army maneuvers, would get no such grueling try-outs. Under strenuous war test, their failings are discovered in short order, so that we may take steps to remedy the deficiencies. Take guns, for example. Without the war, we might continue making large numbers of 3-inch or 4-inch anti-aircraft guns. The one would not have the range needed; the other too much, and at too high a cost. Consequently, we have adopted and are making an in-between gun, the 90 millimeter.

Our observers are learning about war-efficiency of industrial plants. When a plant can continue to make its product in spite of raining bombs, certainly it can teach production tricks to industries in peaceful countries. Close contact with friendly belligerents are showing us how to eliminate wasteful and time-consuming operations and methods all along the line. Vastly important is the problem of keeping a steady flow of supplies of all kinds moving to beleaguered points. The experience of the British is aiding us to organize our transportation systems accordingly. Fire-fighting under war-time hazards teaches us short cuts to greater efficiency; our hospitalization methods, city traffic control, water supplies, an uninterrupted source of gas and electricity—all these are benefitting by observation.

Increased efficiency of production methods, short-cuts, and solutions to old problems are important, but so is the economic phase of the question. Looming importantly over all is the amount we are saving by the speeding up of our own national defense program —which is costing us enough billions already.—*F. D. M.*

ALONG CAME PHYSICS

IN THIS column 25 months ago the belief was expressed that, until a really hard and actual physical working principle underlying the long-mysterious art of dowsing, divining, or water witching by means of forked boughs was discovered and identified, so that physical laboratory instruments could be substituted for the vague uncertainties of the human factor, any investigation of that art must necessarily remain premature. We did not deny that dowsers locate water —we believed, and still believe, they often do—but we wanted the physicists to take over the problem, take some of the occult-mystic-obscurantist hocus-pocus out of it and work it out as an ordinary problem in physical research, leaving the mystics and occultists high, dry and lonesome.

Exactly this now has been accomplished, with a degree of apparent success, by two Englishmen, the biophysicist J. Cecil Maby, B.Sc., Associate of the Royal College of Science, and T. Bedford Franklin, M.A., Fellow of the Royal Society of Edinburgh. Their report takes the form of a generous book, "The Physics of the Divining Rod," having typical earmarks of a technical, laboratory finding in conventional physics.

The investigation proved to be arduous and complex and the report is by no means sketchy. Boiled down to a painful degree, its many conclusions come approximately to this: Every material object and, especially, good conductors in the midst of relatively insulating media, is surrounded by secondary radiation from cosmic rays. The zones of this radiation from these objects can be definitely mapped out in space by means of several physical recording instruments of conventional type, including ionization counters; and, thus mapped out, they check with those mapped out by the ancient method of divining. The working basis of dowsing is the nerves and muscles of the operator, which act as natural ionization counters of electron showers caused by the cosmic rays. One person in ten can learn the art. Both authors learned it.

There is vastly more to the report than can even be summarized here. One ramification of the research puts a possible scientific leg under the famous "Electronic Reactions of Abrams," investigated and pronounced against by this magazine in 1924. This, however, is far from saying that the numerous Abrams proponents were scientific in their methodology, or even that a majority of them weren't exploiting the various "sucker machines" based on the Abrams claims for pelf. Hence we are not upset by the new findings. In fact, at the time the Abrams investigation was made, it was stated here orally that if there actually were any real physical basis to the Abrams reactions, it would not be worked out by the type of "scientist" who mainly was making the most of it (and, we believe, in some measure still is) but by the physicists. The authors lend no real comfort to the followers of Abrams—unless their statement that Abrams' methods are obscure on the technical side, savor of puerility and charlatanism, and are repellent to scientific men, can be called comfort! If Abrams ever "had something there," he and his followers effectively blacked its eye for a long time to come.

It is particularly pleasing, however, to note that our early suspicion that dowsing was not a fake, but has a true physical basis, is apparently verified. The new report will not altogether please those few scientists who all along have pooh-poohed dowsing in toto (without looking into it). Those whom it really will most displease are the occult-minded, for it substitutes the ordinary for the nebulous, the known and commonplace for the mysterious which, to that type of mental makeup, is always the more attractive.—*A. G. I.*

Personalities in Industry

C. V. WHITNEY

It was 1917. The United States had just declared war and a 17-year-old boy named Cornelius Vanderbilt Whitney was in Texas ready to be taught flying by members of the Royal Flying Corps. He had enlisted in the then microscopic United States Air Force after receiving special permission from his parents. Shortly after his arrival at the field young Whitney was introduced to his instructor. He was given an hour and forty minutes flying instruction before lunch. Intensely excited by his new adventure, the boy talked about flying throughout the meal. Immediately after lunch Whitney climbed into a training ship of the "crate" type, so widely used in those days, and set a possible new record for brief instruction by soloing.

He rose quickly from one of the army's youngest air cadets to become an instructor himself—in advanced acrobatic and combat flying at Carruthers Field, Texas, a tough and dangerous job in those days of embryonic aircraft building. Through the years after the war, Whitney showed that same streak for picking tough jobs, persevering through many trials, and finally attaining success.

Despite a background of wealth and social standing, young Whitney had an irrepressible knack for finding his own way, usually with his coat off and shirtsleeves rolled to his elbows. After finishing at Yale, he went to work in the mines at Comstock, Nevada, and for many months dug ore in the lowest levels as a sampler. He rose to assistant mine foreman and then resigned to work in mining camps in other western states. Later he joined one of his father's ventures, the Metal Exploration Company, as assistant to Roscoe H. Channing, Jr., internationally known mining engineer.

Together, Channing and Whitney managed to salvage a little more than a million dollars from a series of mining ventures the elder Whitney had written off his books as a dead loss. The two men set up a small experimental laboratory in Denver in an effort to solve the problem of obtaining commercial quantities of metal from low-grade ores taken from a tremendous copper deposit in northwestern Manitoba—a deposit which other mining companies had been forced to abandon after sinking hundreds of thousands of dollars in the property. It took more than a year of experimentation before a flotation process could be perfected which would insure profitable reduction of the ore.

Within a week he had obtained an option on the ore deposit. He then hurried to New York and showed the option to his father.

The elder Whitney agreed to permit his son and Channing to go ahead. Both men went up to the mine—an arduous journey that required a 100-mile trip by canoe and a trek of another 70 miles along rough trails carrying packs—and set up a pilot plant. Today the Flin Flon Mine, with C. V. Whitney as chairman of the board, is the second largest zinc producer in Canada, the third largest producer of copper, and also mines millions of dollars worth of gold, silver and other metals as by-products every year. Moreover, the town of Flin Flon, built through Whitney enterprise in the heart of the Manitoba wilderness in the early 1930's, now houses 5000 people, while the mine provides jobs for more than 2000 workers.

Whitney carried the same kind of vision and ability into Pan American Airways, which he helped found in 1927 with Juan Trippe, John Hambleton, Grover Loening, Sherman Fairchild, and W. H. Vanderbilt. By sheer gall and persistence this group, led by men like Whitney, built Pan American from a 90-mile line (Key West to Havana) to its present position as the greatest airline in the world, touching 55 countries.

Two other successful ventures backed to the hilt by Whitney's hard cash and intense personal interest are the Beryllium Corporation of Pennsylvania and the Marine Studios at Marineland, Florida, site of two huge oceanariums housing more than 50,000 deep sea specimens.

20 YEARS OF BROADCASTING

IN 1920, radio station KDKA inaugurated broadcasting, using a small antenna and 100 watts of power. Today, 50,000 watts are used; the antenna is 718 feet high. This Westinghouse photograph shows linemen connecting the radio-frequency transmission line, with the antenna in the background. 1940, 20th anniversary of broadcasting, also saw rapid growth of frequency modulation, new broadcasting system that may in time completely replace present-day conventional methods. Details of this new system will be found on page 96 of the present issue.

97TH YEAR SCIENTIFIC AMERICAN FEBRUARY 1941

TIME TO THE SECOND

Modern Tempo of Living Requires Close Timing

MORTIMER H. COBB

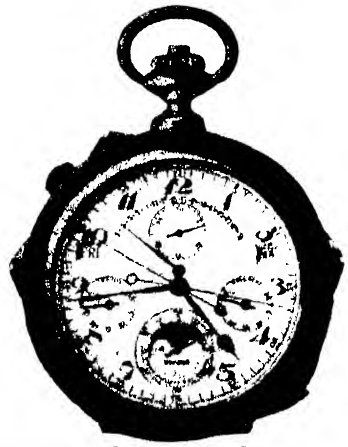
Movement of world events, measured by split-second-timed radio bulletins describing the precision of modern armies, has brought home to a lethargic public that 12:03 P.M. is not "about 5 after 12."

Correct time used to be a luxury; it was hard to get unless one happened to be in a telegraph office when observatory signals were coming over the wire. Today, such exact hours as 11:52¼ have become everyday commodities since the local Bell Telephone Companies in a number of large cities have established accurate Time Bureaus.

A list of persons who require time to the second no longer confines itself to amateur and professional astronomers, railroad men, marine navigators, jewelers, and watchmakers. An up-to-the-minute roll call would also include 360 mile-per-hour airplane pilots to whom an error of 10 seconds would mean a land distance miscalculation of one mile. Radio control men whose daily broadcast schedules may require fitting three foreign programs into one 15-minute period must have time-keepers, even though thousands of miles apart, that agree to a fraction of a second. And so must the interested radio audience. Time study engineers with chronographs (stop watches) reading in tenths of seconds work out the methods of speeding up mass production of textiles or tanks.

To these to-the-second workers must be added the sportsmen: amateur photographers, race track bookmakers, dog field trial judges, the myriad of week-end racing yachtsmen, track coaches, pigeon racing enthusiasts, football, basketball, and hockey referees, and many others. Then there will always be the timepiece collectors and cranks who carry incredibly accurate $1000 pocket watches.

The history of time indicators dates back to about 2000 B.C. To the average man, however, only the year 1600 is important, for it was about that time that the history of modern pocket watches began as a result of German Peter Henlein's invention of the mainspring in 1500.



Courtesy Patek, Philippe & Co., Inc
The day of the week, date, month—phases of the moon—an alarm—stopwatch—*plus*—in this complicated Swiss watch

To understand what time it is on an earth where man makes *his own* time requires definitions of time itself and the various kinds of time he uses. Time is well defined as *measured duration* and the accuracy of that measurement concerns everyone.

There are four kinds of time: Sidereal, true or apparent solar, local mean solar, and standard. Only standard time, as computed by formula from sidereal, is used by the public's clocks and watches. Sidereal time is obtained officially from the stars by astronomers at the United States Naval Observatory in Arlington, Virginia. This star-time is the most precise that man can get and is accurate at its source to within a few thousandths of a second.

True or apparent solar (sun) time was all right for ancient sundials, but with days varying in length at different seasons of the year, only a very complicated clock or watch could keep that kind of time. Local mean solar time would also be impractical for the busy world of today. It would vary for different towns and cities unless they lay in exactly the same longitude; local mean solar time in towns 15 miles apart in the latitude of New York differs by about one minute! Furthermore, scientists with modern instruments can get sun time, by observation, correct only to within 1/10 of a second.

Standard time, adopted by nearly all countries of the world between 1890 and 1895, has as its base Greenwich, England, which lies at $0^h\ 0^m\ 0^s$ Longitude. Mean time anywhere in the world is calculated as so many hours faster or slower than Greenwich, though for convenience the world is divided into 50 time zones. According to standard time, New York City and Flagstaff, Arizona, are exactly two hours apart. Flagstaff mean solar time is actually $2^h\ 30^m\ 54^s$ earlier than New York and $7^h\ 26^m\ 45^s$ earlier than Greenwich, England.

Several times a week, weather and atmospheric conditions permitting, United States Naval Observatory astronomers obtain sidereal time by using a photo-

S. Naval Observatory photograph
'he zenith tube through which stars directly verhead are photographed to check time

graphic zenith tube or telescope. This instrument, that recently has replaced the old stand-by transit or Meridian Circle, is rigidly fixed in a vertical position and cannot photograph any star except those passing very close to the zenith. After making these photographic observations, the procedure is to note the error of the three British Shortt precision clocks that are located in an underground time vault, the temperature and air pressure of which are controlled. These extraordinary timekeepers are never reset or disturbed and maintain an average variation of $0^s.005$ daily. Thus the finest timepieces in the world today are more than 1,450,000 times as precise as those of only a few centuries ago.

Sidereal time is next changed to Eastern Standard Time and the master distributing clock corrected to within a few hundredths of a second. At noon, and other hours when Naval Observatory signals go out over the country by telegraph and wireless, they are correct to within tenths of a second. It should be obvious that the more time is "handled," the less precise it becomes.

For American household clocks and watches that make it easy, difficult, or impossible to catch early morning commuters' trains, the best and most convenient source of correct time is a telephone. In cities where local companies have Time Bureaus, the buzz following the oral announcement is correct to within 1/20 second. In New York City alone, 55,000 time-conscious people use this service daily. In rural sections, the oral response of an operator would be accurate enough for catching a train or ringing a curfew, but not for testing stop watches or rating chronometers or fine watches.

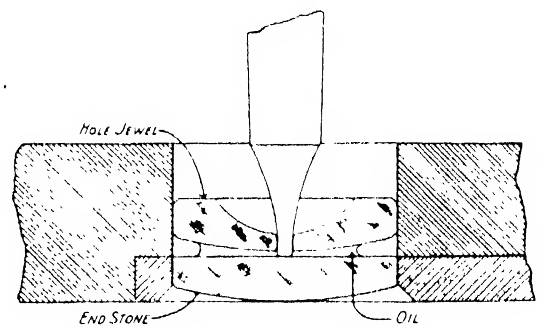
The prototype of really time-conscious radio stations are those with hourly signals (buzz) that originate in the United States Naval Observatory. These are carried by telegraph and transmitted superimposed on the broadcast circuit. Such signals have an average error of less than 1/25 second. This method might well be adopted by radio stations having oral announcements—or bells, chimes, gongs—that frequently vary as much as 15 seconds one way or the other. The worst error on record: a broadcasting company's announcement more than seven minutes late.

The public also has a time service in the electric clocks of the Self-Winding Clock Company that bear the familiar legend "United States Naval Observatory Time Hourly By Western Union." These rented timekeepers, soon to be remodeled according to specifications drawn up by industrial designer Donald Donner, are just what the legend indicates: correct on the hour. Many of these units have no second hands; time is kept only to *the minute*. Real bugaboos of accuracy include electric clocks whose minute hands jump from one minute to the next. For any home, however, the precision of a good electric shelf clock with a sweep second hand will surprise even time cranks.

Another source of correct time that heckles owners of fine pocket watches are the chronometers in watch repair shops and in jewelry store windows. In walking along the better shopping streets of the country, critical and observing persons have noted that several of these boxed and gimbaled portable marine instruments may disagree by many seconds or even a minute or more. Paradoxically, each *might* be correct. Fine chronometers, costing from $400 up, are seldom set. Such chronometers have a known error that, for example, might be an average of 0.2^s slow per week. If the instrument had been set on November first, 10 weeks later the exact time would be the chronometer's reading *plus* two seconds. The same situation exists with reference to large glass-encased precision clocks with long pendulums. Thus, the legend "Correct Time" would be true if such notices also gave an instrument's average error and the date when last set to the second. Even travelers' sentinels—railway station tower clocks—occasionally go berserk. On July 7 last the Grand Central Terminal's clock facing south on Park Avenue cavorted ahead 33 minutes. Station master Smith blamed the heat, not the humidity, for its bad behavior.

Man has always been fascinated by time and its keepers. In the United States, 70,000,000 persons own pocket or wrist watches and continue to buy them at the rate of 5,000,000 a year. A jeweler's or even a pawnshop window well filled with watches invariably attracts a crowd 90 percent of whom are men. Put small diamond or gadgeted watches (ring, lapel, and clip) on display and the lady window shoppers will push the men around.

The Golden Age of watchmaking (1890-1923) has not yet died, but the buying public with its eyes and ears open to the magazine and radio advertising of merchandise stylists will probably kill it. Prior to 1923, domestic and foreign watchmakers made timekeepers in which precision was all important. Wrist watches came in just prior to the first World War and were followed later with wafer-thin pocket models of odd shapes. No watch case having the thickness of a $20 gold piece or the diameter of a dime can possibly have the stamina to stand the jars and jolts of today's fast moving life. Grandfather's old "turnip," the massive

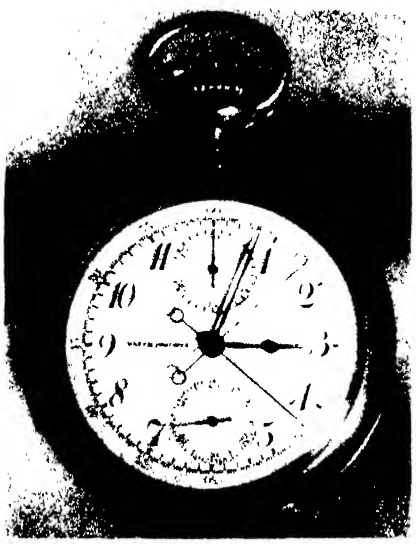


Cross-sectional drawing to show how the all-important jewel bearing is mounted in a watch. The wheel shaft rides within a hole in one gem and against the flat of another, a film of oil being between the two tiny gems
Courtesy Waltham Watch Co

gold watch that was once the mark of a successful man, may be heavy or even clumsy from a mass selling point of view, but as a time measurer it is still the equal or superior of today's watch in the same price range. American "railroad" watches are still thick and #16 size—movement diameter about 1½ inches.

Nearly three-quarters of the watches imported to the United States come from Switzerland and among these are surely *the best and worst watches made anywhere!* Few Swiss factories make all their own parts but instead do a peerless hand assembly, finishing, and adjusting job. Very fine and accurate 14kt gold Swiss, pocket watches that meet the rigorous Class A certificate tests of the observatories at Geneva and Neuchatel start at a minimum retail price of about $250.

The foreign watchmakers are also the producers of very complicated and exceedingly expensive



Courtesy Patek, Phillippe & Co., Inc.
This exceptionally accurate, complicated watch—16 size, 39 jewels—costs $2750 and worth it

hand-made watches of which any owner can justly be proud. Drawing plans, making parts, and assembling such intricate and delicate machinery frequently takes eight years. One of the most complex timepieces ever made was a double-faced pocket watch with 975 working parts. It was valued at 20,000 gold francs in 1900.

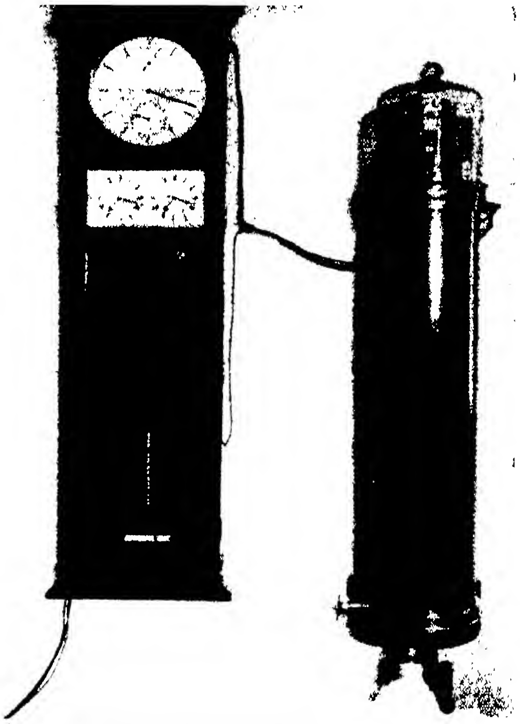
Aside from telling the time of day with precision, its versatile dials and attachments include: (1) day of the week, (2) perpetual calendar of months and dates for 100 years, (3) moon phases, (4) the four seasons, (5) apparent solar time, (6) chronograph in fifths of a second with register for hours and minutes, (7) dial showing how long since the mainspring was last wound, (8) automatic striking of hours and quarters, (9) manually worked repeater striking hours, quarters, and minutes on three gongs of different tone, (10) Boreal sky with sideral time and 460 stars, (11) Austral sky with sidereal time and 250 stars, (12) the local time in 125 towns and cities, (13) hour of sunrise and sunset, (14) a thermometer, hygrometer, and barometer, (15) altimeter registering up to 5000 meters, (16) a complete regulating system, and (17) a compass. On the face of it, this watch would meet the everyday requirements of almost anyone except a race track tout who wants to time two horses running in the same race. It was no doubt an oversight, but this museum piece lacked a double split-second timer.

American watches on the other hand are machine-made and microscopically inspected for mass production. It would be unfair, however, to compare stock models of the Elgin National, Hamilton, and Waltham Watch Companies that retail for less than $300 for a 14 kt. gold pocket watch with a hand-made foreign watch costing $1000. Late in the golden age of watchmaking, both Elgin and Waltham made $750 pocket timekeepers in 18 kt. gold cases with no gingerbread on them. These magnificent #16 size watches probably marked the peak in the American industry and were unquestionable as precise as the world's best. Dollar for dollar, today's American railroad watches will measure time with any others.

No parallel can be drawn between wrist and pocket watches. When checked against an accurate time source, a medium-priced pocket watch will far surpass an expensive wrist watch. Compare the two-week performance of a $150 wrist and $37.50 pocket watch used simultaneously by a business man:

In 15 days, the wrist watch lost nearly three minutes and its rate was irregular, for on the fifth and ninth days it gained. The pocket watch gained a little over two minutes, and while its rate was regular, its error was large—8.7^s per day. Neither is a good timekeeper, but the pocket watch was more consistent.

For anyone to guarantee abso-



U. S. Naval Observatory photograph
The Shortt precision clock—with its slave—is regularly checked against known star

lute accuracy in a watch would be absurd; there is no such thing as a perfect time measurer. The number of jewels in a watch should be a guide to its quality. When carried, a seven-jewel pocket timekeeper should maintain a steady variation rate of 15-20 seconds daily; a 15-jewel, adjusted to several positions, should be accurate to within 4-8 seconds; and a 21- or 23-jewel, adjusted to five or more positions and temperature and isochronism, to within one second. In the latter class, however, only 16 size, U. S. railroad watches or fine Swiss movements will live up to that high standard. Anyone who wants to better the second-a-day average will pay for it to the tune of about $500 for each quarter-second increase in daily accuracy of rate.

If one is lucky enough to own a fine watch, here are some simple rules that will tend to keep it that way: Wind it in the morning at the same hour and not too tight; set it infrequently, merely note its error; do not place it on a cold object as a sudden change in temperature will change its rate and might snap the mainspring; have it cleaned and oiled once every two years by a competent watchmaker (the work may cost 10-15 percent of a watch's value, but it's worth it); don't ever open its inner case, and protect it from pocket dirt with a small chamois bag; within reason, avoid all possible sudden jolts, X-ray machines, and machines that are magnetic. Is that asking too much thought for an instrument you wish to tick accurately 157,680,000 times a year?

Better Health From the Sea

Vitamin A from Shark Livers, Varied Products from Weeds, Form Growing Industries

ANDREW R. BOONE

Around the fringes of 45 submarine forests off the southern California coast and along fishing banks scattered from Seattle to San Diego, fishermen are staging an unusual "gold strike." They're harvesting vitamins in unbelievable numbers from shark livers and from oils of other deep-sea fish; iodine, minerals, and laxatives from sea weeds forming the vast under-water forests.

This strange rush for health-giving products of the ocean started in earnest three years ago when A. H. Meyer, a fish buyer of Monterey, California, sought to purchase livers of the six varieties of sharks found in San Francisco bay and along the coast to Point Loma. This unusual offer resulted in the landing of 914,205 pounds of shark during the following season. Last year, some 13,000,000 pounds entered seven harbors, producing more than 1,600,000 pounds of livers. Most valuable specie is the soupfin, whose livers, many times more potent than any other natural source, yield in late summer 75,000,000 vitamin-A units per pound. The sardine, tuna, northern halibut, and the sable fish, or rock cod, provide excellent sources of vitamin D, negligible in shark livers.

Some soupfin shark livers weigh 20 pounds, are four feet long

Meyer's sensational buying order resulted from visits made by two groups of industrial chemists, sent from their eastern headquarters to investigate the possibility of finding high-vitamin content sea foods and medicines. Their analyses revealed tuna oil to be very high, with northern halibut even richer. Then two western scientists became interested. Dr. H. N. Brocklesby, through research at the Prince Rupert Fisheries Experiment Station, found that certain shark livers contained 100 times more vitamin A than do cod livers, oil from which long has been a stand-by in the nation's medicine chest. "Vitamin A in fish," he explained, "probably comes from microscopic sea plants known as photoplankton, through small marine animals called zooplankton, which in turn form the food supply for smaller fish, later consumed by larger species. The livers of some retain the vitamin A and accumulate a reserve."

Packed in five-gallon cans, the livers are frozen before shipment to canneries, where the vitamin-rich oil is extracted

Frozen smelts: good shark bait

Meanwhile, 1500 miles farther south, at Terminal Island, W. L. Scofield, fish-oil expert for the California Division of Fish and Game, urged that large fish-canning organizations employ research men. He pointed out that as sardines are disappearing, sardine meal, widely used as a poultry food, must be fortified with vitamins from other sources to make smaller amounts carry larger food and therapeutic values. As a result, canners today are scrambling for vitamins. Oil from mackerel, tuna, and shark is being added to sardine meal; poultry and stock gain pounds and flavor accordingly.

With fishing in the Norwegian countries greatly curtailed by war, and imports from other nations diminished, scientists expect the Pacific Ocean to furnish a great quantity of vitamins, plus important minerals and other medicines, during years to come.

How rich the shark livers will prove ultimately has not been definitely determined. Pinback, grayfish, bonita, thrasher or whiptail, and leopard sharks all supply vitamin A, but the soupfin has the highest potency of all. These fish weigh from 35 to 90 pounds, and some soupfin livers measure nearly four feet in length. Smart fishermen, wise in the ways of their finny

victims, try for female soupfins carrying eggs. At the start of the gestation period, in late May, livers may run only 8000 units a gram. In two weeks, they increase to 12,000; week by week, the potency leaps to 18,000, 42,000, finally 180,000. Since buyers pay according to strength, fishermen hope for the golden harvest about six weeks after the season opens.

These sharks are not man-eaters and, although they have no bones, strength being supplied by cartilage, they are true fish and are caught in nets and on set lines. The latter consist of as many as 6000 hooks suspended at intervals from a horizontal line, tied at the ends to buoy cables leading to kegs and corks, and hauled up at three-hour intervals. Sharks inhabit the bottom, and are taken at depths of 60 to 1500 feet.

Every night fleets of refrigerated trucks race along California highways carrying sharks to packing sheds. By midnight, livers have been pulled from the carcasses and packed in five-gallon cans. When the sun rises, each liver has been frozen; and by the next evening, it has reached a reduction plant, where machines begin to extract the oil and chemists measure the vitamin content.

Methods of extracting vary from heating minced livers in open tubs and skimming off the oil to secret techniques where every step follows a laboratory control. Each company keeps its process a deep secret, but basically the new processes require coagulation and pressing. One canner recently developed a three-phase separator which dumps the solids in a bowl while the oil is flowing out the top, speeding production and extracting nine tenths of the oil content.

So rapidly has the business grown in recent months that fishermen and canners alike say a $20,000,000-industry, based upon shark livers alone, will soon be developed. Already, many skins are made into leather articles such as shoes and traveling bags; the teeth make novel jewelry; Chinese use the fins as soup stock; the flesh, finely ground, becomes nutritious live-stock feed; and the liver oil, undiluted or added to other products, helps restore health to ailing individuals. In many cases the liver alone proves more valuable to the fisherman than did the entire fish only three years ago.

While men in boats angle for vitamin-laden fish, others along the shore, from Los Angeles harbor to Point Loma, shove forks under the water, into rocky clefts, and bring up a queer, red seaweed known as Gelidium. Sometimes divers walk along the bottom, snipping Gelidium for surface harvesting.

Fresh from the sea, tons of sharks are loaded on trucks, like cordwood, then rushed to refrigeration plants

For five days, the Gelidium lies on the beach, drying. Following dehydration in this manner, trucks carry the fronds to National City, where they are washed in open vats, then forked into iron baskets, which are transferred to closed digestors and heated by steam coils until a jelly emerges from the cookers. The jelly is dried, pressed through a wire screen, and the stringers frozen to force out the remaining moisture. You may know the final dry product as agar, widely used to treat constipation, while every hospital and research laboratory in the country employs the jelly as a culture medium, in which bacteria multiply with incredible speed. This common weed has no other known value, yet it has saved countless lives by enabling scientists to view rapidly growing disease bacteria while patients await treatment or surgery.

Thousands in the so-called "goiter belt" of the midwest have good reason to thank another weed of the sea, which thrives off the southern California coast, for better health. These submarine forests grow luxuriantly along a 250-mile stretch of sea from Point Loma to Gaviota, where 45 beds have been surveyed, some singles and others groups of forests. Mostly, they thrive within a half-mile off the shore; several sway with the tides around groups of islands, as far as 40 miles out.

Three raw kelp factories send out harvesters equipped with long, curved scythes to prune the top branches from the plants, the only known perennial of marine algae. Much as you mow the lawn, the scythes draw the branches back; an endless belt lifts them up, depositing the slippery stems on the floor of the harvest boat. When loaded, the barge-like boat steams under its own power into San Pedro or San Diego. Because the mowers take only the top six feet, and the stems grow rapidly, the submarine forests, owned by the state of California and leased to the harvesting companies, contain a seemingly inexhaustible supply of kelp.

You seldom hear of this weed, yet very likely it reaches your dinner table or medicine chest in some form. At waterfront plants, the leaves and stems are first hung to drain in the sun. In a day or so, they move on to low-temperature dryers designed to preserve the nutritional properties which otherwise would escape into the air, finally are pulverized to a flour by grinding, and screened. Some is

sold in bulk as animal feed, the balance formulated for dietary deficiencies.

Not long ago eight head of cattle, fed exclusively on kelp, won first prize as the finest displayed at a western stock show. Many cows in the midwest, fed kelp meal, give milk containing iodine, necessary in treatment of goiter. Recently, Michael J. Walsh, San Diego chemist, discovered that kelp meal pressed into tablets will bolster some inadequate diets. This year he will turn out nearly 1,000,000 pounds of kelp products. Algin, taken from the same weed, when used in manufacturing ice cream, prevents formation of ice crystals and yields a smoother, more velvety texture.

Unloading kelp, harvested from under-sea forests of Pacific

Neptune's locker of riches has scarcely been tapped. These seagoing farmers first will harvest the easily available crops. Gold, radium, untold quantities of bromine and iodine, plant forests nearly a quarter-mile below the surface remain to be exploited. The seas hold sources of health and wealth beyond the dreams of Midas.

• • •

VERIFICATION

An Ice Bag on The Forehead Lowers Brain Temperature

HEADACHE victims who find an icebag on the forehead soothing, really are cooling off that part of the brain right through the skull. So Dr. William Bierman, and Dr. Mae Friedlander, of Mount Sinai Hospital, New York, recently reported to the American Congress of Physical Therapy. *Science Service* asserts that this came about as the result of an unusual opportunity to measure brain temperature of a human being.

While ice bags lay on the forehead of a patient from whom a brain tumor had been removed, Dr. Bierman inserted a thermocouple into the frontal part of the brain. Two inches below the forehead surface, the brain was found to be cooled a degree and a half, Fahrenheit.

Cold has received less attention than heat as an ameliorating influence in disease, the investigators stated, but they predicted greater use for cold. Their experiments with human beings indicate that cold applied to skin surface penetrates deeply. Ice bags on the calf of a patient's leg lowered the temperature deep within the leg muscles as much as 26.4 degrees, Fahrenheit. Testing the general supposition that drafts of cold air have no particular effect upon structures lying beneath the skin surface, they blew cold air on the leg calf and found that within the muscles the temperature dropped as much as 11 degrees. Cold applied to the abdomen seems to influence organs within, though the cooling was not very great.

EYESIGHT

Given to Blind Person Necessitates Adjustments

THE average person, blessed with sight from birth, cannot easily imagine the plight of one blind from birth who has his sight restored. The Better Vision Institute reports on such a case, a boy who received his sight after he had reached the age of 18.

This boy, George Campbell, had sightless opaque lenses in his eyes at birth. Three years ago the opaque lenses were removed and specially designed spectacles of great focusing power were provided. George Campbell could then see, but because co-ordination of mind and body had for 18 years been adjusted to the senses of touch, hearing, and smell, a complete readjustment had to be made, based on the appearance of things as he saw them.

The normal person takes for granted such simple things as a glass of water and a glass of milk. George Campbell, however, could not determine which was which merely by looking at them; even if he had been told, when blind, the difference between transparency and opacity, he still had to learn by experience exactly what those two terms meant. He had to learn to distinguish visually between a foot rule and a yard stick. His eyes required long training to work together in unison. For months, when he saw two cars approaching each other to pass on a road, his vision was so inexperienced that he shrank back in fear because the cars appeared to his eyes to be rushing into unavoidable collision.

TWO HEARTS

Beat As One, in a Manner of Speaking

"TWO hearts that beat as one" may be only a poet's fancy, but a scientist has just discovered that if the two hearts belonged to husband and wife, even though they do not really beat as one, they are likely to stop beating at the same age and even from the same cause.

Husbands and wives tend to have the same length of life or vitality, and when one of them dies of cancer, heart disease, tuberculosis, influenza, or pneumonia, the other is more likely to die of the same disease than could be accounted for by mere chance, Dr. Antonio Ciocco, of the U. S. National Institute of Health, has reported to the National Academy of Sciences.

Death records of 2571 married couples who died in Washington County, Maryland, between 1898 and 1938 revealed these surprising findings.

Being subjected to the same environment and living conditions and a tendency to select a husband or wife of the same constitutional type as one's self may be the reason or reasons why husbands and wives live about the same life span and die from the same one of five diseases which kills one of the couple. The tendency of both husband and wife to die from cancer cannot be explained on the basis of contagion, which might conceivably explain why both would die of tuberculosis, influenza, and pneumonia if one of them died of such a germ-caused disease.—*Science Service.*

BROWSING with the Editor

EGGS BY FREIGHT—Due to better methods of packing, loading and handling, loss and damage to eggs shipped by rail has been reduced 84 percent since 1921.—Notes, Association of American Railroads.

MORE MILES PER GALLON—An increase from 87 to 100 in octane number allows a plane to carry 1200 pounds less fuel, 1200 pounds added useful load, on a 1400-mile flight.—*Science and Culture* (Calcutta, India), October, 1940.

MILK WOOL—Add to rayon and nylon another word with an "on" ending. "Prolon" is the name suggested by F. C. Atwood for the new family of protein-base fibers such as those made from the casein of milk.—*Industrial and Engineering Chemistry.*

SKIDDING AND TIRES—Results of 3000 actual tests on packed snow and icy surfaces, made in Michigan, show that, although tires having good treads are preferred to smooth tires on dry and wet roads, they give no better performance than smooth tires on snow and ice; also that while lowering tire pressure or increasing the load over the rear wheels gives increased traction on slippery surfaces and a slightly increased traction for stopping, this is more than offset by reduction in safe speed on curves.—*Highway Research Abstracts*, November, 1940.

LAZY SHARKS—Speaking of the insensitiveness of whale sharks, Captain R. W. Mindte, of the motor vessel *Invader*, says: "I know of two authentic occasions when fishermen have stepped off the fishing racks on to the backs of these sharks and walked and jumped on them, the sharks apparently taking no heed of this action."—*Science Service*, October 18, 1940.

GAS, CHEMICAL RAW MATERIAL—Chemists are using 350,000,000,000 cubic feet of gas a year as a reactive agent between nitromethane and formaldehyde, to form a product that can be acted upon by nitric acid to make a new explosive more stable than TNT.—Notes, American Petroleum Institute.

COUSINS MOVING IN—At present there are eleven gorillas living in the United States—*Fauna*, Zoological Society of Philadelphia.

A MAGNET!—The magnet of the new 4900-ton cyclotron to be built at the University of California will be 56 feet long, 30 feet high, and over 15 feet wide. The cyclotron should be completed by 1944.—General Electric Company notes.

HOW BOMBED WINDOWS BREAK—Instantaneous photography of seven-foot-square, quarter-inch, plate glass windows used in experiments shows that the damage occurs in two stages. In the first, during the compression period the center of the glass is forced inward as a diaphragm, and ring and radial cracks develop. In the second, before the pieces have had time to separate, the "suction" half of the wave comes into effect and the pieces fall toward the bomb, except when the bomb is very near the glass—in which case the broken pieces are driven away from the bomb from the beginning.—*Journal of the Institute of Physics.*

ADAPTATION—Duck-bills illustrate an important principle of evolution. They show that various lines of animals at different times adopt similar modes of living, as the duck-billed dinosaur of sixty million years ago, a reptile, the duck-billed-platypus of Australia, a mammal, and the ordinary duck, a fowl.—Henry Fairfield Osborne: "Evolutionary Trends."

MACHINE TOOLS—Practically the entire output of the nation's vastly expanded machine-tool industry is destined for the national-defense program of the United States. Machine-tool production which totalled $185,000,000 in 1929 and averaged $23,500,000 in 1932 and 1933, rose to $200,000,000 in 1937, reached $400,000,000 in 1940, and probably will reach $600,000,000 in 1941. Nearly half our national tool employees have been trained on the jobs since September 1939.—Notes, National Machine Tool Builders' Association.

MAGNETIC STORM POWER—During the great magnetic storm of April, 1938, energy was expended at the rate of two billion kilowatts for a two-hour interval. This is 100 times the capacity of all the hydro-electric developments in the country.—A. G. McNish, of the Department of Terrestrial Magnetism, Carnegie Institution of Washington, in *Edison Electric Institute Bulletin.*

MOLASSES FOR ROADS—Numerous attempts have been made in many parts of the world to find inexpensive binders to stabilize earth surfaces (for low-cost country roads) and attention has inevitably turned to the employment of by-products or waste-products of local industries. Of these, molasses, obtained in the refining of cane sugar, has been found to give results of considerable promise.—*Civil Engineering* (London), October, 1940.

SUBMARINE SPOTTING—When a belligerent aviator sees a submarine, he drops aluminum powder to form a "slick" because he is travelling too fast to keep the location in view otherwise. Returning, he easily finds the submarine's location.—Notes, Reynolds Metals Company.

STOMACH ACID—The destructive action of carbolic acid on the skin is not due to its strength as an acid. Actually the acidity of the human stomach (due to hydrochloric acid) is 25,000 times that of a fatal dose of carbolic acid.—*Monsanto Magazine*, November, 1940.

VITAMINS IN INDUSTRY—One company feeds vitamin A to employees and saves money on its electric range production. This vitamin maintains normal level of visual purple in the retina of the eyes of workers, so that they can detect off-color parts of electric ranges. The result has been a saving of thousands of dollars.—Westinghouse Electric & Mfg. Co.

"GAS" FOR THREE MONTHS—If some fanciful cataclysm were to destroy every oil well in the United States, there is so much oil and gasoline in storage tanks that we could supply ourselves and part of the rest of the world for three months while new wells were being drilled.—*Oil Weekly.*

Fighting Friction

Just How Friction Operates Between Metals Is Not So Simple as it Sometimes Seems

WALTER L. FINLAY, Ch.E.
Research Chemical Engineer, Remington Arms Company

BLITZKRIEG or war of attrition? Whichever form of suicide the war lords of the future select, man's ancient struggle with friction will quite literally, as in the long dim stretches of the past, be one of grinding attrition—a mutual wearing down of human energy on one side, and of the obstacles which bar man's insatiable drive to move bits of his environment about on the other. Whether for good or for ill, this ofttimes seemingly aimless motion is nevertheless essential. It is at once the surest characteristic and the imperative necessity of life. And, as every schoolboy knows, negativing and almost inseparable shadow of motion is friction.

It is of course a commonplace to point out that friction is both friend and foe to man—likewise are fire and water. The battle centers about their control, and the good news is that, in the past several years, the control of friction has been greatly strengthened by important advances in both knowledge and technique.

Just how does friction operate? The first cave man who grumbled and cursed when he had to shove a log along the ground undoubtedly was well aware that the smoother he trimmed the branches off the trunk the smaller was the amount of energy he had to expend for shoving and the greater was the amount available for grumbling. Thus happily engaged, he probably blamed the remaining friction, if not on some evil spirit, then on the smaller protuberances still marring the smoothness of the trunk. In the present world of the machine, however, shoving logs over earth is a relatively unimportant operation, whereas the sliding of one metal over another touches the very core of a mechanized civilization. The simple view of friction—that it is the interlocking of more or less tiny roughnesses on the sliding surfaces—is only a very crude approximation to the true nature of friction for metals. A wholly clear understanding of the mechanism of sliding friction is even today not to be had, but the key to the picture is this: No surface is perfectly smooth. Under the heat and pressure of sliding, the high spots on the two surfaces weld together and the frictional resistance arises when these metallic junctions are ruptured by the continued motion of sliding. Sliding friction thus resolves itself into alternate sticking and slipping.

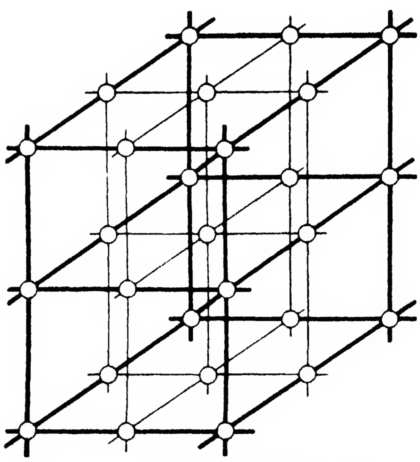


Figure 1: **Conventionalized representation of metal structure**

STARTLING and unexpected are some of the details of this general picture.

First, under many conditions of sliding the surface temperature rises rapidly to the melting point of the material having the lower melting point of the two, although there is no evident sign of heating and the bulk of the material remains cool.

Second, two seemingly perfectly flat surfaces, except under excessively high pressures, touch only in a very few high spots. For example, the actual area of contact between two highly polished steel surfaces may, under quite usual circumstances, be less than one ten-thousandth of the apparent area.

Third, not only is the actual area of contact between two highly polished surfaces very much smaller than the apparent area, but it is also practically independent of the apparent area. To illustrate, suppose one highly polished plate 10,000 feet square is placed on a very much larger but equally smooth plate. The actual area of the high spots which touch, and which form the only contact between the surfaces, would be in the neighborhood of only one square foot. Now, if the top plate were sliced into, say, ten thinner plates and these were placed side by side, the apparent area of contact would have been increased ten times, or to 100,000 square feet. But, notwithstanding this, the actual area of contact would still be only approximately one square foot. Conversely, if, instead of slicing, the 10,000 square-foot plate had been cut up into ten equal pieces and these had been piled one on top of the other, the apparent area of contact would have been reduced ten times, or to 1000 square feet. Nevertheless, the actual area of contact would still be only approximately one square foot.

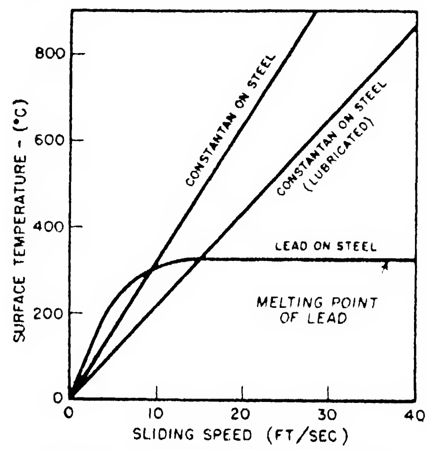


Figure 2: **Showing how easily friction melts lead. Constanstan (alloy principally of nickel and copper) does not similarly melt**

Fourth, if a group of very husky individuals took to pushing the aforementioned steel plate around, they would find that, no matter how they sliced it up, so long as they pushed it about as a unit, the frictional resistance would be about the same. And, furthermore, they would find that, no matter how fast or how slow they pushed it, the frictional resistance would still remain practically unchanged.

Such paradoxes could be multiplied, but it is more interesting to inquire into the mechanism which gives rise to them.

During the past few years a small group of English scientists — notably Bowden, Tabor, Leben, Hughes, and Finch — have been conducting a thorough investigation into the fundamentals of friction and it is largely to them that the present extent of our knowledge is due.

Bowden and Tabor arrived at a determination of the total area of contact between two surfaces by measuring the electrical conductivity. The electrical conductivity through the faces is in proportion to the actual area of contact; hence, the greater the area actually in contact, the greater the conductivity. They found that the actual area of contact was not greatly affected by either the size, shape, or degree of roughness of the surface, but that it depended mainly on the *pressure* squeezing the plates together. This finding makes quite a logical picture: the highest high spots make the initial contact. If their combined cross-sectional area is insufficient to support the load, the junctions flatten by plastic flow, thus increasing their cross-section and also bringing into operation new, lower, high spots. This augmentation continues until the total cross-section is just sufficient to support the load.

THE question now arises: what happens when one of these "smooth" surfaces is slid over the other? Perhaps the most significant contribution to answering this problem was made by Bowden and Leben a few months ago. They, painstakingly, and with considerable ingenuity, simultaneously measured the friction, the conductivity, and the surface temperature as two highly polished metals slid over each other. To understand their results one must first appreciate what happens when two high spots make contact.

In the first place, the modern concept of a metal is that it is an assembly of positive ions held together by the attraction of the intervening electrons. Figure 1 attempts a much simplified representation of a metallic lattice. The circles represent the nuclei of the atoms; the lines joining them, the cohesive bonds. The bonds of those in the center of the assemblage are completely satisfied, but those at the surface may be thought of as having excess cohesive forces extending out from the surface. Hence, when two high spots come into contact, the surfaces weld—that is, the excess cohesive forces clutch the newcomers, become mutually satisfied and the junction simply disappears. Meanwhile the base material, of which the high spots are a part, moves on, but since the new junctions resist this motion, whole blocks of atoms get ripped out and considerable heat is evolved. So sliding proceeds: a series of stick-slips which, with certain reservations, permits one to consider kinetic friction to be a series of static frictions.

Figure 3: **A remarkable spark photograph taken at the Peters Ballistic Institute, showing the effect of sliding of lead on steel at higher than lead's melting speed. Insert is virtually an end view of the molten "tail"**

Shifting from the atomic viewpoint, Figure 2 shows what occurs over the surface in general during sliding. With a load of only one quarter of a pound, a block of lead moving at any speed faster than about 16 feet per second over a polished steel plate generates so much heat by the rupture of momentarily welded high spots that the temperature of the surface actually attains the melting point of lead. Yet, 16 feet per second isn't even a respectable speed; so-called low velocity bullets loaf along in a steel barrel at close to 1000 feet per second, while such speedsters as the .220 Swift reach a muzzle-speed almost 300 times faster than that necessary to melt the surface of a lead bullet. The unusual sparkograph shown in Figure 3 gives some idea of the frictional heat developed when a .25/35 soft point, jacketed bullet (2000 feet per second) inadvertently had its cupro-nickel jacket cut through by rust-roughened rifling. The heat of the friction melted the lead core and the spiralling "tail," photographed at 20 feet from the muzzle, is composed of drops of the molten core which the centrifugal force of the spinning bullet forced out of the perforation in the jacket. The left-hand insert is a photograph of the pattern made by the bullet and its tail when they impinged on a target paper four feet farther.

SURFACE melting is general on sliding surfaces and is common to all materials at relatively low rates of speed. And, furthermore, regardless of any increase in the load or in the speed, the surface temperature cannot be raised even one degree above the melting point of the material having the lower melting point. Hence, no matter how hard a material may be, it cannot polish another unless it has the higher melting point. Thus, camphor, which is quite soft and melts at 178 degrees, centigrade, can polish the much harder but lower melting Wood's metal, but cannot touch the softer but higher melting tin.

As a generator of heat, polishing is equally effective whether two sliding surfaces or two arguing scientists are concerned. Is polishing accomplished by abrasion—the filing off of solid aggregates of atoms on a submicroscopic scale—or by melting and smearing of the surface atom layers? Newton, Her-

schel, Rayleigh, and a host of others favored abrasion; after 20 years' investigation the late Sir George Beilby built up a very convincing case in favor of the melting and smearing hypothesis which presumably gave rise to the polish layer now universally known as the Beilby amorphous layer. Recent studies with the electron diffraction camera, not to be confused with the electron (refraction) microscope, have added further to the weight of evidence favoring the existence of this layer. Certainly it seems clear that part of the process, at least, is an intense, localized heating at the points of contact, so that melted or softened solid is smeared over the surface where it solidifies with extreme rapidity to form the Beilby layer.

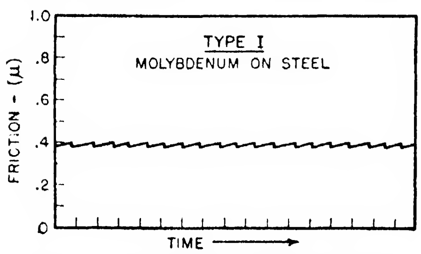


Figure 4: **Metallic friction, Type I: High melting on low melting**

The depth of the Beilby layer ranges from 10-30 atoms to more than 100,000. It has been found that the "running in" of a piston results in the formation of an extremely thick Beilby layer. In the case of aluminum piston rings it was found that an amorphous layer of aluminum oxide was formed, but that continued running in converted the amorphous aluminum oxide into crystalline aluminum oxide, which is nothing more nor less than sapphire, a very hard material. Thus, although aluminum piston rings are softer and lighter than cast iron rings, they cause much greater cylinder wear because they become studded with tiny sapphire teeth.

It must be emphasized that it is only the surface—and, indeed, only the high spots of the surface—which is raised to the melting point at the relatively low speeds graphed in Figure 2. The bulk of the material may remain quite cold. This is strikingly illustrated by the fact that, although a meteor, whizzing for a brief moment through the atmosphere at 30,000 to 150,000 miles per hour, becomes white hot on the surface, it nevertheless is quite cool before the startled person it just missed can collect his (almost) scattered wits and go over to examine it.

Bowden and his collaborators found that there were at least three distinct types of metallic friction, and that these were determined largely by the melting points of the metals:

Type I—High Melting Sliding on Low Melting: This has appropriately been compared with pulling a number of plowshares through hard ground. As the pull increases, the plowshares are pulled into closer contact with the earth. Suddenly the ground gives and the plowshares jerk ahead. The cycle then starts anew.

Figure 4 shows how Type I friction varies, as exemplified by molybdenum sliding on low-carbon steel. The high spots on the molybdenum dig into the softer steel and the friction increases. Then there is a sudden slip before repeating the process. During the sliding, well-defined furrows are grooved out of the metal having the lower melting point, but the metal of higher melting point remains unscratched.

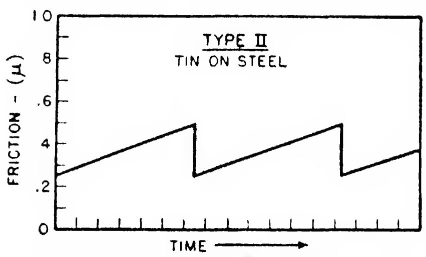


Figure 5: **Metallic friction, Type II: Low melting on high melting**

Type II—Low Melting Sliding on High Melting: As in Type I, the friction varies in jerks, as shown by Figure 5 (tin on steel) but the extent of the rapid slip is much longer. In Type II the heat and pressure of sliding weld the high spots of the slider to the high melting surface. Then, as the friction increases, the junctions are drawn out finer and finer, until, with a "flash" of heat, they break. After the resulting sudden slip, the process repeats.

Type III—Two Surfaces of the Same Metal: In this case widespread welding takes place and both surfaces are deformed and locally melted by the subsequent ruptures. Hence, as Figure 6 (silver on silver) shows, there are no rapid slips, although large fluctuations occur and the average value of the friction is considerably higher than in the other two types.

In everyday experience an overlapping of these three distinct types often occurs. Consider, for example, the common case of a lead bullet fired through a steel barrel, that is, a low-melting metal sliding on a high-melting metal. If the lubrication on this bullet is at all faulty, then metal-to-metal sliding occurs and the friction is of Type II. In this type, it will be remembered, the lead high spots solder to the steel. Thus, eventually, the steel becomes smeared over with lead and the shooter grumbles that his barrel has leaded up. If this deposit is not removed, then succeeding bullets encounter Type III frictional resistance, which constitutes much greater drag and usually involves greater distortion of the bullet surface, since essentially one is then dealing with a lead bullet in a lead barrel. Where friction is to be minimized, the sliding surfaces should, of course, be of dissimilar metals. If this is not possible, then some non-homogeneous alloy like steel (which is composed of at least two quite dissimilar constituents—soft iron, and hard iron-carbide crystallites) should be employed, rather than a homogeneous metal like pure iron, which is composed of soft iron crystallites alone.

The preceding analysis of friction into three types is for unlubricated surfaces exposed to the air. Such exposures mean, in general, two things: an oxide layer is formed and a film of gas molecules (oxygen or nitrogen, or both) is rather strongly attached to the surface by the excess cohesive bonds of the base material. Both of these sheaths tend to insulate the excess cohesive bonds of the two surfaces and thus to reduce the friction.

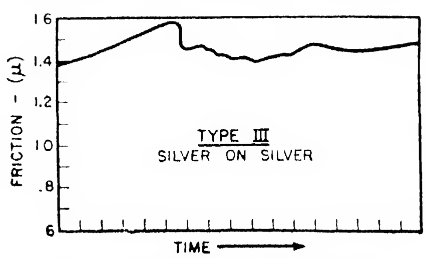


Figure 6: **Metallic friction, Type III: Two surfaces, same metal**

Hence, when both oxide and adsorbed gas are removed and the friction is measured in a vacuum, the resistance to motion is found in every instance to have increased considerably—in the case of nickel sliding on tungsten, for example, it increases nearly 20 times.

Lubrication, of course, also modifies the mechanism. But the value

of the Bowden analysis is that it represents the normal basic condition and upon it, as a foundation, a rational picture of everyday friction can be built. Flooding the surfaces with a suitable lubricant and using light loads, for example, is one common condition. In this case, the excess cohesive bonds of the surfaces are drowned in the thick film of lubricant and the frictional resistance is due entirely to the viscosity of the lubricant. Hence the variations of friction with the pressure, the thickness of the oil film, and the velocity of sliding can be entirely accounted for by the laws of hydrodynamics.

But in this day of high speeds and great pressures it is often impossible to maintain such a cushion of lubricant. Hence one characteristic of a good lubricant is that it be adsorbed on the sliding surfaces. If this primary adsorbed film constitutes all the lubrication, the lubrication is termed "boundary." But, even with boundary lubrication, the surface, as shown by Figure 2, undergoes a rapid temperature rise. One therefore concludes that the adsorbed film is continually being punctured as the high spots break through and weld. The ability to prevent puncture up to very high pressures is the outstanding property of so-called "E.P."—extreme pressure—lubricants but, in view of the high local temperatures which are now known to be involved, it has been suggested that E.P. lubricants might better be termed "extreme temperature" lubricants.

From the constant emphasis on the high spots of apparently smooth surfaces it is obvious that, the more these can be leveled off, the easier will be the job of the lubricant. An outstandingly successful move to accomplish this on a wide industrial scale has been achieved by the Chrysler Corporation's recently introduced "Superfinish" process. The basic principle of Superfinishing is that the abrading agency shall never retrack, but shall always trace out a new path. The path of least resistance is to follow and hence to perpetuate a previous scratch. By simultaneously moving both the abrader and the work, Chrysler has avoided this and has thus set up a new and higher standard of surface finish.

Thus, in the past few years the reconnaissance by Bowden and the flanking attack by Chrysler have considerably reduced the stature of Foe Friction. Needless to say, however, the war of attrition on attrition will go on, for each advance in this war is the essence of progress itself—the more efficient utilization of energy to make more things better.

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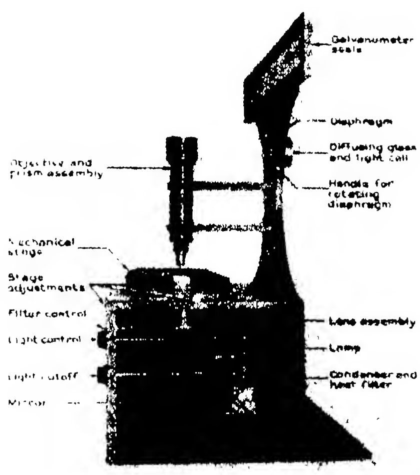
PHOTOMETER

Eliminates Human Element In Spectrographic Analysis

A NEW photometer for application to transmission measurements where small areas are important has been developed by the General Engineering Laboratory of the General Electric Company. The instrument is especially valuable in such work as quantitative spectrographic analysis because it eliminates the "human element" in comparing the densities of spectral lines, thus reducing errors to the minimum.

The new photometer shown in our illustrations was developed to provide the compactness, mechanical simplicity, ease of operation, and flexibility necessary to give the best results in applications such as this. The arrangement of the instrument allows the operator to see a magnified portion of the exact field which is being measured.



Cutaway of transmission photometer for spectrographic plates

Several apertures are provided in the screen, but these may be easily changed by changing the position of the diaphragm. The slit diaphragm can be rotated to align closely the image of the spectral line with the slit aperture, and there is provision in the diaphragm

Newly developed transmission photometer, especially valuable in quantitative spectrographic analysis and transmission measurements involving small areas

for any shaped aperture to accommodate special conditions of measurement as may be required by the work in hand.

After final adjustment, the optical parts remain fixed and require no further movement for focusing. Spectral lines are focused on the screen by moving the plate plane with respect to the objective; thus the magnification always remains constant.

MARCH OF TECHNOLOGY

Research Necessary to Plan For More Stable Economy

IN THE report on Technology on the Farm, prepared by an inter-bureau committee of the U. S. Department of Agriculture, the foreword opens with the following two paragraphs:

"In this book we count the cost and values to American farmers of some new changes in machines, animals, plants, tillage, and processes. During the industrial revolution of the 18th and 19th Centuries, workers tried to stop a relentless transition to mechanization by breaking the machines they thought would eliminate their jobs. They failed.

"Our times are like that period or are, perhaps, a continuation of it. It would be useless for us to try to curb this march of technology, for we know that it gives jobs, as well as takes them away. Our task, rather, is to study ways to equalize the advantages brought by technology and to help plan a more stable economy."

Sun-Spot Distribution

What Had Seemed to be an Anomaly Proves to be an Optical Effect with Odd Cause

HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

For more than 50 years the Sun has been photographed on every clear day at Greenwich, and for almost as long at other observatories, with telescopes giving images some inches in diameter, upon which small spots can be clearly seen. At any one station, the records will be often interrupted by clouds; but the observatories at Greenwich, Mount Wilson, the Cape, and Kodaikanal in India, have for a long time co-operated, sending to the others copies of plates made on days when their friends had bad weather, so that an almost continuous record is available. On every day's plates the number of spots is counted, their areas are measured, and the position of each on the Sun's surface is determined—in heliographic latitude, measured from the solar equator, and the corresponding longitude.

These records provide the source material for many important investigations. They tell us of the distribution of the lives of individual spots—from a single day to a maximum of six months; of the growth and disappearance of spots and spot-groups; of the rotation of the Sun, and the differences in its rate at different latitudes. Followed over a longer interval, they exhibit the great cyclical changes in spot-activity, with maxima recurring at intervals of about 11 years, but not accurately periodic, and the equally noteworthy changes in the latitudes at which spots appear.

All these topics have been extensively studied; but they do not exhaust the material. In 1907, Mrs. Maunder, wife of one of the staff at Greenwich and an astronomer in her own right, studied an apparently simple matter—the distribution of spot-groups upon the apparent disk of the Sun.

In any given year of the sunspot cycle, the spots are practically confined in latitude to two fairly narrow belts on each side of the Sun's equator. This must have a real physical significance: It means, doubtless, that the outbreaks of spots are symptoms of some deep-seated process occurring in the Sun's interior; but we do not yet know what this process is.

The distribution of spots in longitude, along one of these belts, when measured with respect to a starting point rotating with the Sun, would be uneven, if there were regions of the surface especially prone to these disturbances. But if the longitudes are measured from the central meridian of the disk, as seen from the Earth, we should expect a uniform distribution—especially since the Sun's rotation carries the spots across the disk in a fortnight, so that. from day to day, they are recorded in different longitudes on this system. Yet Mrs. Maunder found that, in equal intervals of longitude, there were five times as many groups recorded near the central meridian as were recorded close to the edge of the disk.

This enormous difference cannot possibly be due to a real influence of our tiny Earth upon the Sun's surface. It must be an optical effect of some sort, and mean that our chances of observing a sun-spot are much better when it is near the middle of the apparent disk than close to the edge.

Why something of the sort should happen is obvious. At a point near the middle of the disk, our line of sight comes down almost at right angles to the surface. Near the edge, it approaches the disk more and more obliquely. Markings on the surface (which we will, for the present, imagine to be spherical and perfectly smooth) will therefore be seen foreshortened at an increasing angle, and, close to the edge, may appear so much narrowed as to be practically unrecognizable; and the finer details will certainly be lost.

The effect is illustrated in the drawing, which represents a cross-section of the spherical Sun. The Earth is far away at the top. The black lines represent the region occupied by sun-spots of the same sizes at different distances from the central meridian. For a circular spot, the diameter at right angles to the plane of the page will not be foreshortened, and the spot, on the solar photograph, will appear elliptical. Very near the limb the spot will appear narrowed almost to a line, of length equal to the true diameter.

With the recognition of this effect, the matter was practically dropped for more than 30 years. It has been taken up by Dr. Archenhold—a German refugee, working, when his paper was written, at the Solar Physics Observatory, Cambridge, England.

The apparent area of a spot, as measured on the photographs, will be greatly diminished by foreshortening. It is a simple matter of geometry to correct for this, and the "Greenwich Photoheliographic Results" give, in addition to the apparent area, the "corrected area" increased by a factor corresponding to the foreshortening. One might expect that this correction would get rid of the difficulty altogether; but things are not so simple as this.

It is evident that, for a given telescope and a standard quality of seeing—that is, of blurring of the photographic image by dancing of the image—there will be a definite lower limit to the size and area of a sun-spot which can be detected. On the Greenwich plates, for spots near the center of the disk, this area is close to one millionth part of that of the Sun's visible hemisphere, which corresponds to an apparent diameter of 2".7 for a circular spot.[1]

As far as 70° from the central meridian, the apparent areas of the

[1] A spot having a millionth of the area of the visible disk would be of 1/1000 of the Sun's diameter, and this is 1".92. But the curved area of the visible hemisphere is just twice the flat area of the apparent disk, so that the unit is twice as great, and corresponds to an apparent diameter $1.92 \times \sqrt{2}$, or 2".7.

smallest visible spots average about the same. But, not a single spot out of more than 5000 was recorded more than 80° from the center unless its area was at least ten times this limit. Such spots on the photographs would be distant from the edge of the disk by less than 1/100 of its diameter, and greatly foreshortened, appearing almost like lines parallel to the edge. Dr. Archenhold makes the excellent suggestion that such a line (really, a very narrow ellipse) will escape observation unless its maximum width exceeds a certain limit which, on the Greenwich photographs, he finds to be 1″.4. Moderate-sized spots, close to the limb, would then be lost, because their images were too narrow to appear. On this assumption, the change in this corrected area of the smallest visible spots can be accounted for up to 85° from the central meridian. Here a spot is lost unless it has 33 times the area (or, if circular, nearly six times the diameter) of a spot visible at the center. Simple geometry shows that the image of such a spot on the photograph would be but 1/12 as wide as it was long, and be distant from the edge by only 1/500 of the diameter of the disk. It is rather surprising that it shows up at all!

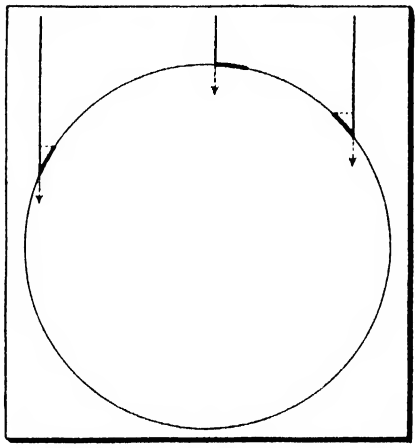
The geometrical effects appear now to be satisfactorily allowed for; but they do not by any means account for all the observed lack of spots near the edge. Comparing, for example, the zones 60° to 70° on each side of the central meridian with the central zone within 10° of it, Archenhold finds that the numbers of spots of corrected area five "millionths," found on equal areas of the Sun's surface, are as 12 to 52.

There seems to be no other way to account for this than to assume that a sun-spot looks smaller when seen obliquely than when seen squarely. The geometrical foreshortening has already been allowed for, and the "narrow-line" effect should not appear, as the area is more than double the limit of visibility, even at the edge of the outer zone.

To get 12 spots for the standard area in the central zone we must go to those of corrected area 13, which may be taken as the "normal" area corresponding to an observed area of 5 (corrected for foreshortening) at 65° from the central meridian.

Dr. Archenhold finds that this effect is present for spots of all sizes, from the smallest up to 200 millionths. The actual increase in area is greatest for the larger spots, the percentage increase for the smaller ones: Spots 70° from the meridian, and of "corrected" areas 10, 30 and 50, correspond to "normal" areas of 28, 55 and 80.

We are now faced with an insistent question. This effect is clearly indicated by the observations; but does it make sense? How can it possibly be that a sun-spot should shrink to only 60 percent of its apparent diameter, just because we look at it at an angle of 70° to the Sun's surface, instead of squarely down at it?



Foreshortening of sun-spots

If the Sun's surface were solid or liquid, or an opaque flat sheet of clouds, this question would be unanswerable. But it is nothing of the kind; the gases of the outer layers are simply hazy, with an opacity increasing gradually downward, so that, even when we look squarely at the surface, we "see down" to a considerable depth—that is, much of the light which we receive comes from well down in the luminous fog, though weakened by scattering by the overlying haze as it gets out.

When the light comes out obliquely we "see down" to a smaller depth, as is clear from the dotted arrows in the drawing. Now a sun-spot is a region where the gases are cooler than elsewhere, and therefore shine less brilliantly. If, for any reason, this cooling is greater in proportion to the depth from which, on the average, the light comes out at right angles to the surface than at the shallower average depth for obliquely emitted rays, the spot might look smaller when seen by the latter.

The problem thus comes down to one of the detailed constitution of a spot. We have a fairly good general idea what happens. A column of gas, ascending from the unobservable depths, is cooled by its own expansion, and, when it reaches the surface, forms the spot. There is little doubt that these ascending columns are in rapid rotation, with a motion the reverse of water running out of a basin, and that this rotation produces the magnetic field. On this picture, we should expect the upper portions of the ascending, funnel-shaped vortex to be the widest, and, as Dr. Archenhold points out, to find the spot bigger if observed in its upper layers. But this assumes that the ascending vortex reaches right up to the surface. There is pretty good evidence, however, that the level at which the ascending vortex flattens out into outward radial motion (think of the wash-basin, again backward!) is below the very small depth to which we can see, and that in the outer, visible layers, there is no further cooling by expansion. In this case, the visible layers simply form an atmosphere above the cooler pocket of gases below and the size of the visible spot should correspond to the size of this pocket, no matter at what depth within the outer layers we made our observations. The smallest visible spots are 1500 miles in diameter, while the depth to which we can see, below the level where haziness begins, is probably not more than 100 miles. How the influence of the cool pocket underneath could be neutralized in such a very thin, superficial layer, sufficiently to reduce the apparent size of the spot, is by no means easy to imagine.

The "physical foreshortening" of the spot-areas discovered by Archenhold is, however, apparently well established, and adds one more to the problems of the solar physicist, and to the clues which may lead him ultimately to a logical solution.

Mrs. Maunder's work brought out the still more curious fact that the diminution in the numbers and areas of spot-groups is greater at the western edge of the Sun than at the eastern. Archenhold finds that, for individual spots, this effect, though present, is much smaller. The solution of this puzzle can hardly be expected to precede that of the other.—*Princeton University Observatory, 1940, December 4.*

Robot Photographic Observer

Army Air Corps Develops Power-Driven Movie Camera for Test Flights

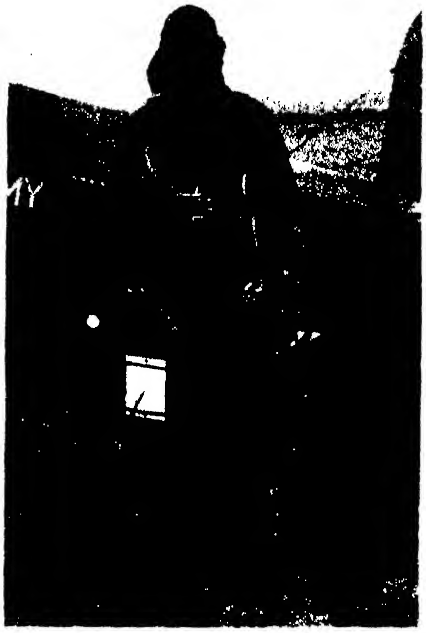
ALEXANDER KLEMIN
Aviation Editor, Scientific American
In charge, Daniel Guggenheim School of Aeronautics, New York University

In the early days of test piloting the observer was required to jot down readings of several instruments on a pad loosely held on one knee. As plane speed increased, the accurate recording of flight data via pad and pencil became well nigh impossible. The Materiel Division of the Army Air Corps has met this situation through the development of a "Photographic Observer," an apparatus in which the readings of all necessary instruments are simultaneously recorded by an automatic camera.

Preparing flight observer for installation in rear cockpit of two-seater military airplane

The component elements of the photographic observer unit, which is approximately 20 inches long, are a 35-millimeter, motor-driven motion picture camera, a two-part lamp house held together by toggle bolts, and the instrument panel on which are mounted the recording instruments essential to the evaluation of airplane operation, or for some flight research work. Although these instruments are identical with others of the same type on the pilot's instrument board, the duplication is unavoidable.

The device is the result of several years' development work, and has proved entirely satisfactory. The camera has a special wide-angle lens in lieu of the standard lens so that seven instruments may be photographed simultaneously. The instrument panel is of sheet aluminum with black finish to eliminate light reflection. As sufficient light is of prime importance to obtain clear pictures, there are six Mazda lamps located 4½ inches in front of the instrument panel, but outside the field of the photographed area. Operation is a simple matter, since lights and camera operate from a single electric circuit which is plugged into the gun-control system. During test flights, the electric gun-switch is turned on so that when the pilot wishes to actuate the photographic observer, he does so merely by pressing the gun trigger on the control stick.



Antiquated pad and pencil method of observation recording, now replaced by motor-driven motion picture camera

The photographic observer is particularly valuable during take-off tests, when the various instrument readings change rapidly. During climb tests the pilot must make a three to five second photographic run of the instruments at every 1000 feet of altitude. In radiator tests, a multiplicity of temperature readings must be taken. The new device makes the lot of the scientific test pilots and observers a good deal easier.

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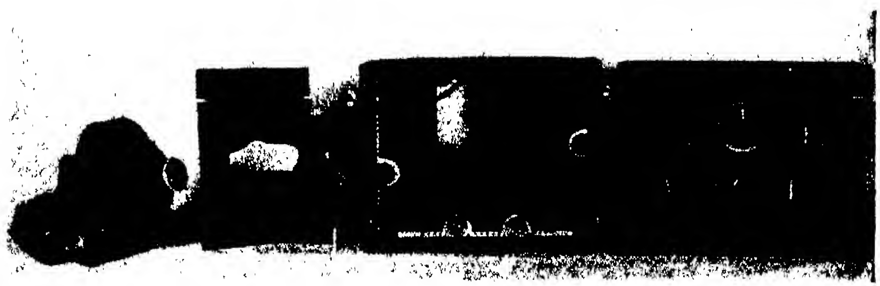
INEXPENSIVE

Network of Seaplane Floats Dots Waterways

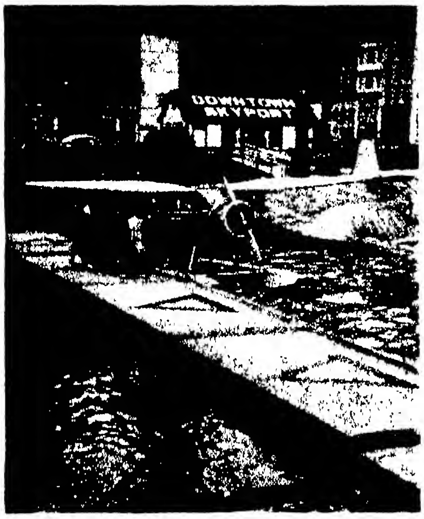
Thanks to co-operation between the National Youth Administration, the Civil Aeronautics Administration, and certain municipal authorities in the erection of floating bases, the owner of a light seaplane may now fly the entire length of the Atlantic coastline with greater comfort and safety. Starting from the float of the Downtown Skyport in New York City, the private flyer would find similar seaplane landing facilities at Philadelphia, Atlantic City, Baltimore, Washington, and Norfolk. Ports along the North Carolina



Left to right: 35-millimeter, motor-driven motion picture camera; two-part, toggle-bolted lamp house, and recording instruments on the panel

coast include Elizabeth City, Beaufort, and Wilmington; in Florida, Daytona Beach, Miami, and Key West, all of which, together with many others, are listed in the Civil Aeronautic Authority's "Directory of Seaplane Floats and Anchorages," a compilation of bases, anchorages, and refueling facilities throughout the country.

Buoyancy of a typical 10 by 22-foot float is provided by ten 55-gallon steel drums, which may be

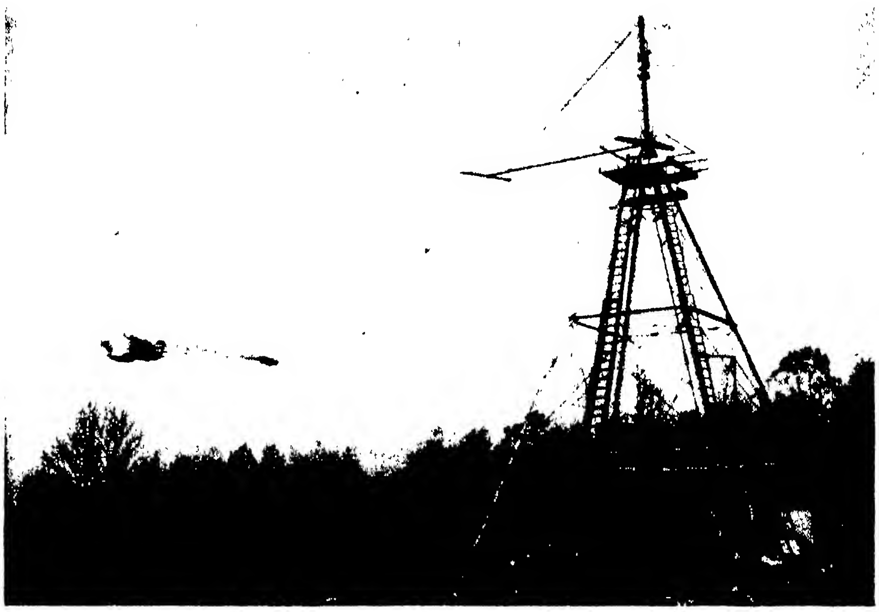


At lower end of Manhattan Island and symbolic of days to come, is New York's Downtown Skyport, patronized by many sportsmen flyers and business men who daily fly to work

moved individually by running them through one of a series of hatches built into the floor boards, thus eliminating the necessity of overturning a float for drum repairs. Skids are attached to the bottom of the float to facilitate winter removal from the water, and the deck is painted the standard international orange color, with black triangles for identification. Although labor costs may vary under the co-operative plan, each city pays only $150 for the materials, and private flyers are delighted with the availability of these bases and are patronizing them in increasing numbers.—*A. K.*

COCKPIT RELEASE

At Wright Field, the experimental station of the Army Air Corps, there has been developed an automatic release for instrument flying hoods. A Pitot tube type airspeed indicator, instead of actuating an arm on a dial, actuates two pairs of electrical contacts. By suitable adjustments, electrical contact is made at two predetermined speeds —for example, 130 miles per hour and 230 miles per hour. When the single-seater pursuit type training plane reaches either the low or the high limit of air speed, a relay operates a solenoid. The solenoid automatically releases the hood of the cockpit, reducing a hazard in blind flying training for the student who may be diving or stalling without knowledge that he is doing so.—*A. K.*



Motor-driven boom, revolving at 70 to 300 miles per hour, tests the action of parachute opening, which is recorded in slow-motion pictures

TEST TOWER

Parachute Action Studied Through Slow-Motion Pictures

As several things happen almost simultaneously and with considerable rapidity in the course of a parachute jump, the jumper is not ideally situated to take observations, a dilemma that has created considerable difficulty in the past in studying the functioning and aerodynamics of the parachute. The wind tunnel, a magnificent instrument of aeronautical research, is adapted to study constant conditions rather than the rapidly altering conditions of the opening of a parachute. The Pioneer Parachute Company offers a solution by erecting a special parachute test tower, shown in the photograph.

The parachute test tower is a mechanism built for the purpose of whirling a dummy "jumper" around in a 200-foot diameter circle at speeds varying from 70 to 300 miles an hour. A horizontal boom is mounted on the tower about 50 feet above the ground and is rotated by means of a gear train and a vertical drive shaft driven by a 320-horsepower marine engine. To the end of the boom are fastened flexible streamlined rods which support the dummy. To the dummy, in turn, are fastened the parachute harness and pack. The tower functions in somewhat the manner of the "flying machines" which are seen at pleasure resorts. As the boom revolves, the dummy swings up from the ground and ultimately travels in the same plane as the boom itself. A light cable is attached to the "rip cord" of the parachute at any desired position, and at about one third the distance from the boom end to the dummy there is a spreader fastened between the flexible streamlined rods. On the spreader is mounted a high-speed motion picture camera which operates automatically after the rip cord has been pulled and provides excellent slow-motion pictures of the functioning of the parachute during the process of opening.

As the dummy does not act gravitationally, and as centrifugal force is a factor in the tests, but not in the actual jump, the method is open to minor criticisms. It is, nevertheless, a valuable addition to the art of parachute jumping, and experiments with the test tower and its automatic camera observer should produce additional information and clear up doubtful points in parachute theory and practice.—*A. K.*

We Build More Ships

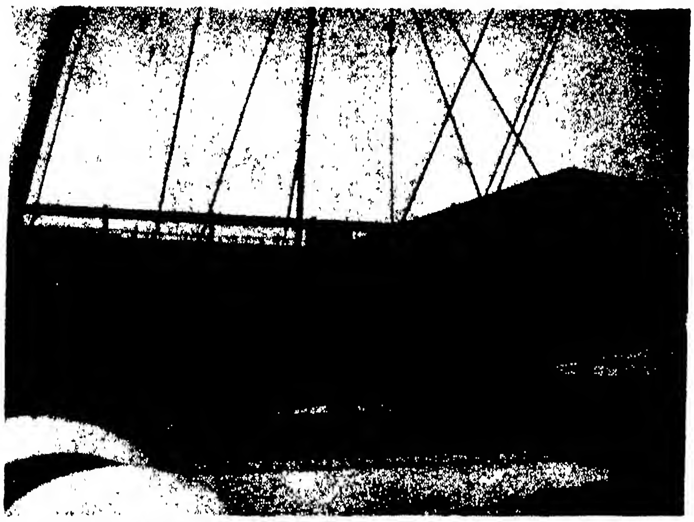
Our Merchant Fleet Adds About One Ship A Week — Efficient, Economical, Safest

W. CREIGHTON PEET, JR.
Secretary, U S Maritime Commission

FROM the middle of the Nineteenth Century to the World War period, the American merchant marine was only a minor factor in international trade. There are numerous reasons for this, among the most important of which are the facts that American initiative following the Civil War was turned inward to the development of the enormous resources of the western United States, and that European merchant fleets were able to operate at costs which American ship operators could not meet. It was not until 1917 that the need for a fleet of merchant vessels, able to serve in time of need as naval auxiliaries, became obvious to our government. Since that time, the problem of merchant shipping as it affects national policy has been centered more and more in our fleet of merchant ships in international trade.

Carriage of our foreign trade in American ships could never, of course, be a monopoly. If American ships were to handle 40 or 45 percent of the total of our international trade, there would be work for all our ships and a guarantee of adequate service for our foreign trade. But, regrettably enough, we are carrying no such percentage of our imports and exports. As a matter of fact, the percentage has been decreasing steadily for several years. In 1928, 38 percent of the total tonnage of our imports and exports was shipped in American bottoms. By 1938, the figure had shrunk to 26 percent of the total.

The reasons for this decline are simple. First and among the most important of the reasons is our aging, slow, and relatively inefficient merchant fleet, for the most part a relic of the wartime fleet which was designed to be built in a hurry, primarily to transport troops and supplies, and not to carry peacetime foreign trade. A second reason is the increasingly nationalistic practices of some foreign nations which seek to build up foreign exchange by requiring that goods shipped from their shores be carried in their own vessels. A third was the large increase in the volume of our foreign trade—from 51 million tons in 1933 to 75 million in 1938—with, at the same time, a decrease of over 50 percent from 1933 to 1940 in the number of United States vessels registered for foreign trade.



Photos courtesy The Grace Line

Symbolic of the unity of the western hemisphere nations: a shipment of machinery for Latin America

There was a time in America's past when she actually was merchant queen of the world. In the age of the clipper ship, 1845-1860, United States vessels skimmed the cream from practically all international trade. The clipper ships were the fastest things afloat. They cut days of time from the schedules of ordinary sailing vessels. In the 1850's, our clipper fleet carried approximately 72 percent of our total imports and exports! The reason was, quite simply, that the clippers led the world in speed and efficiency. There were not many of them—but they were the best ships in the world.

Today's problem of recapturing our fair share of world shipping is being solved by imitating the example of our forebears in sail: by building for ourselves a merchant marine which will be, not the largest and not even necessarily the cheapest, but the speediest, the most efficient, the most economical, and the safest in the world.

We are modernizing our merchant fleet with replacements which can compete in the carriage of freight in practically every one of the world's sea lanes. We do not expect ever again to obtain such a monopoly of shipping as we had back in the 1850's. We do not want it, for it is bad economics. What we do expect is that as a result of the current shipbuilding program of the Maritime Commission, we will once again be able to "skim the cream" of international trade.

As of July 1, 1940, the United States fleet of merchant vessels in foreign trade numbered 425 vessels of 1000 tons and over, nearly 90 percent of which were 20 years old or more. Such vessels are considered "overage."

An overage vessel, while not necessarily worn out, is swiftly reaching the point where it cannot compete satisfactorily in international trade against modern vessels. By actual count, all but 39 of the ships built prior to the Maritime Commission program in our merchant marine will be overage in 1941.

NEARLY 50 merchant vessels, put into service during 1939 and 1940, as a result of the construction program of the United States Maritime Commission, comprise the nucleus of our new merchant fleet, as authorized by the Merchant Marine Act of 1936. This Act defined the national policy on the nation's merchant marine, and set up the Maritime Commission to put it into effect. In the preamble to the Act, two principal reasons are stated for an adequate, modern merchant marine carrying the American flag. These are: such a

fleet is necessary to serve our industry and agriculture by protecting our vital export markets and by providing ourselves with the essential materials which we do not produce; and the national defense requires a merchant fleet to act as the service arm of the Navy in time of war.

THE principal features of the Act through which the Maritime Commission is directed to achieve its aims are: It abolished indirect subsidy of the merchant marine as it had been practiced through the ocean-mail subsidy contracts. It provided for a direct operating differential subsidy to private lines serving essential trade routes; that is, payment of an amount representing the difference in operating costs between American vessels and foreign-owned vessels on a given trade route. It provided for a direct construction differential subsidy—payment of the difference in cost of construction of approved vessels in American and in foreign shipyards. It provided for the gradual replacement of aging and obsolete vessels by modern, efficient, and safe ships. It provided for the training of American seamen, and the establishment of minimum wage and manning scales and working conditions.

In other words, this Act put the United States on record that insofar as possible the government would place domestic operators on a parity with foreign competitors in order that a substantial portion of our trade might be carried in vessels of United States registry. Originally, the program contemplated the construction of 50 ships a year for 10 years. Actually, in the three years since the first contracts were signed, nearly 200 vessels have been contracted for. As of October, 1940, 49 of the vessels, including the *America*, had been completed and placed in service. Twenty-two of them are serving the increasingly important inter-American trade routes.

More than half a dozen distinct types of vessels are being included in this broad, carefully planned building program.

The *America* is a 26,500 gross ton passenger liner built at Newport News, Virginia. The largest merchant ship ever constructed in the United States, it was assigned to transatlantic service but, because of the war, it is being utilized successfully as a cruise ship to Caribbean ports.

One of the early projects of the Commission was the construction of 12 high-speed, twin-screw tankers which would be valuable to the Navy. Ordered by the Standard Oil Company of New Jersey, with the Commission paying the cost of national defense features, they have already demonstrated their commercial

Ships to carry our foreign trade go down the ways regularly

efficiency, and at least one operator runs them at their full speed of 18 knots. The Navy has bought four. In addition, 11 single-screw tankers with national defense features are now being built.

The C-1 cargo vessel is a small, 14-knot freighter designed to fit the minimum requirement on American trade routes of the world. Thirty-eight of these have been ordered.

The C-2 cargo vessel is a 15½-knot vessel. This was the Commission's original design, intended to provide the most urgently needed replacement in the American commercial fleet. These ships have already proved themselves the most efficient of their type in the world. Sixteen are already in operation. Forty have been ordered thus far, as have also three adaptations of the basic design, which will carry a certain number of passengers.

The C-3 cargo vessel is somewhat larger and faster — 16½ knots. It will serve trade routes requiring rapid carriage of goods. Some of this type are already in service on the American Republics Line to South America. Eighteen have been ordered.

With the same hull design as the C-3 cargo vessel, a combination passenger and cargo ship, which will permit passenger travel on similar trade routes, is being constructed. Fifteen of these have been ordered, of which seven are intended for 'round-the-world service.

The Seas Shipping Company, operators of the Robin Line to South Africa; the Mississippi Shipping Company, operators of the Delta Line from the Gulf to the east coast of South America; and the American Export Line, which operates into the Mediterranean and to India, are all building vessels of their own design with the help of the Commission. They will replace aging vessels of the fleets of these companies. Eighteen have been ordered.

In addition to these, the Maritime Commission plans to build two fast passenger liners for the Pacific trade, even larger than the *America*. They will be about 30,000 gross tons with an overall length of 760 feet and with engines capable of a service speed of 24 knots. They will be convertible into fully equipped aircraft carriers; with stacks on the starboard side, an unobstructed flight deck can be quickly erected.

BECAUSE the United States merchant marine is vitally important to the nation, it is receiving extensive support financially and otherwise from the Government; but it should be emphasized that it is operated by private industry and is still part of our private profit system. The ship operators in most cases own their own ships, and if they do not, they charter them from the Government on a bareboat basis just as one would rent a house.

The new Commission vessels are fast; they are economical to operate; cargo handling gear is of the most modern type; extreme precautions have been taken to make them the safest ships afloat. The safety features of the new vessels have been planned to cover every conceivable contingency which could be met with on shipboard. A list of the new developments in safety equipment alone would take up more space than this article has had allotted to it. Every precaution has been taken to make the vessels as nearly fireproof as it is possible

to build them. The dangers of sinking as a result of collision are minimized, since every ship is compartmented so that even though one compartment might be flooded by some accident, the vessel still will float and be able to proceed under its own control.

There is no doubt but that the new fleet of 500 vessels planned by the Maritime Commission under the authority of the Act of 1936 will restore to the United States its rightful percentage of world trade. The costs of the program are not heavy, when all factors are taken into consideration; and, moreover, every cent spent on our merchant marine is well spent not only from a trade point of view but also from the point of view of national defense. The Navy will have an efficient and capable service arm in the new merchant marine, ready for any emergencies.

However, the first purpose of a merchant marine is—trade. And as far as trade goes, world conditions have changed rapidly since the Maritime Commission was first created. Many countries have ceased to exist as separate entities. Markets that were here yesterday are gone today. Trade restrictions have multiplied and an urgency for foreign trade has become inextricably interwoven with the ambitions of great nations. As these developments take place, we hear of the enormous losses of shipping facilities suffered not only by the belligerent powers but by neutral nations as well. United States flag vessels, however, are increasing steadily in number and are still operating over many

Fire inspection drill: an officer going down into a ship's hold

essential trade routes. They are carrying our exports to those geographic areas where markets still exist, and are bringing back to this country those critical and strategic materials so vital to the maintenance of our own economic structure.

Finally, with modern, fast cargo and combination cargo-passenger ships constantly being added to the merchant marine of the United States, one may expect that, as the merchant fleets of other nations become depleted, the vessels of this country will be in a position to carry—at least for some time to come—a substantial portion of the total cargo tonnage which will move in international trade during the post-war period.

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FLOATING POWER PLANT

Would See Service In Emergencies

INTEREST in national defense being what it is, the thoughts of A. P. Kellogg, General Electric turbine engineer, have turned to the question of floating power plants. Recently he made designs of a 50,000-kilowatt floating power station which may be constructed as part of the national defense program. In the event the generating facilities of a city of 150,000 to 200,000 were destroyed by bombs, this power plant would, in a short time, be towed to a near-by spot and hooked in to the town's electrical distribution system to keep industries going and to provide lights.

In describing the proposed ship to the Wisconsin Utility Association recently, Kellogg said the west coast, Great Lakes region, and a large portion of the eastern United States could be reached by generating stations housed in vessels designed to pass the United States Barge Canal. The plants, he said, would always be useful to meet varying industrial needs.

Generators of the aircraft carrier *Lexington* supplied power to Tacoma, Washington, in 1929 during a water shortage. Since 1930, a 20,000-kilowatt floating power plant in the S.S. *Jacona*, owned by the Public Service Company of New Hampshire, has been in service on the Piscataqua River near Portsmouth, New Hampshire.

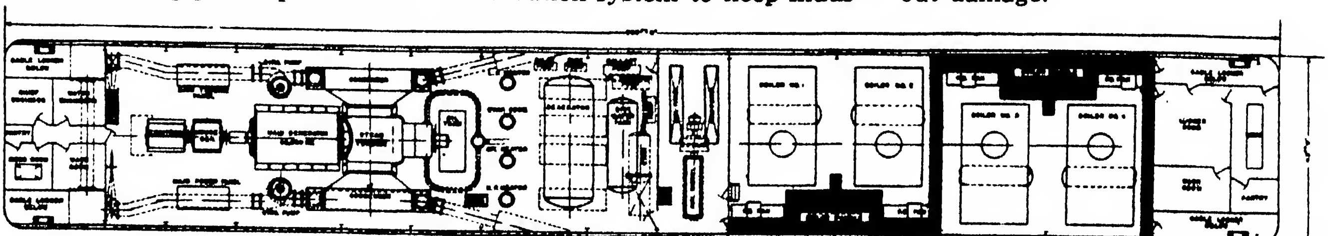
TEST BOMB

Determines Power Of Explosives

EXPLOSIVES are specifically developed for their destructive powers. However, in order that they may be used with perfect safety, it is necessary that their explosive powers be accurately known. That calls for laboratory testing, a ticklish job which demands absolutely dependable equipment. A failure may be fatal.

In the laboratories of one American explosives manufacturer, testing is accomplished in a 30-inch "test bomb" 12 inches in diameter. Explosives are placed inside and detonated. The bomb is so strong that, instead of bursting, it confines the gases, measures the pressure of the explosion, and thus determines the potency of the explosive.

The test bomb is a veteran of many bombardments. Research men have exploded countless charges within its chamber. It has withstood their force because it is made of a special chromium vanadium machinery steel which is tough enough to confine the tremendous generated pressure without damage.



Plan view, at turbine deck, of the proposed 50,000 kilowatt floating power plant

Eye Science Moves Forward

Vision, Precious to All of Us, is Aided and Saved By Optical Industry's Developments

DR. J. F. NEUMUELLER
Director, Bureau of Visual Science, American Optical Company

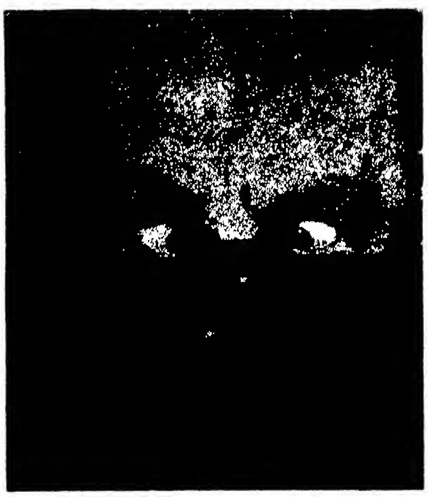
IF YOU are one of those millions suffering from defective eyesight, thank your lucky star you are living in the year 1941 A. D. The modern oculist, optometrist, and optician, assisted by the optical industry's scientific developments—sensitive measuring instruments and versatile lenses that are truly precision-ground—can now test and correct your faulty vision with a degree of accuracy undreamed of a few years ago.

At the turn of the century, for example, a paper test chart and two or three crude, simple examining devices constituted the equipment then available for eye diagnoses. Leaf back the pages of history a few more years, and there were no eye-testing instruments available at all. Trial and error was the only procedure for prescribing glasses.

Consider the case of the aging gallant of 1850. When his eyes could no longer recognize the fair ladies promenading down the avenue, reluctantly he visited a spectacle shop or called in an itinerant spectacle peddler and tried on successive glasses until he found a pair that seemed to help his failing vision! Nowadays we need not gamble in such fashion with nature's most precious gift: sight.

The human eye is the hardest worked of all bodily organs, one of the reasons why 25,000,000 Americans wear glasses and 60,000,000 should. The majority of eye defects are errors of refraction—that is, some part of the eye is so constructed that the organ cannot focus light rays correctly on the retina. Located in the back of the eye, the retina corresponds to the film in a camera and transmits the images formed upon it to the brain via the optic nerve. The four common refractive defects are near-sightedness, far-sightedness, astigmatism, and double vision, all of which are now understood and corrected by use of eye glasses.

Six years ago, Dartmouth research scientists announced the discovery and treatment of a fifth eye defect to which had been given the musical name of aniseikonia—Greek for "unequal images." It may be explained that aniseikonia is present when a person looks at an object and the image received through one eye differs in size and shape from the image in the other eye. The brain's visual center gallantly attempts to fuse the two unequal images but often fails dismally. This futile struggle may result in headaches and stomach and nerve disorders.



Pair of very crossed eyes exercised on the stereo orthopter

The most important effect of aniseikonia in single binocular vision is loss of the capacity for judging depth and distance. Obviously, a motorist or airplane pilot so afflicted is a potential menace to himself and others. Significantly, it was concluded that aniseikonia was a possible solution to those baffling eye cases not aided by the customary examination and correction. And of these there were many.

An exceptionally complex instrument is used to detect aniseikonia whose correction necessitated the development of a new type of lens to produce equal images in both eyes. These lenses were designed by Dartmouth research scientists. To the American Optical Company was entrusted the problem of translating these designs into actual lenses. These iseikonic lenses are tailor-made; that is, each one must be individually designed and ground, and no two are ever alike. They are the most difficult and intricate of all prescription lenses to manufacture. Yet thousands of aniseikonic victims have had their faulty vision corrected since the discovery was announced in 1934.

The detection of aniseikonia illustrates splendidly the optical industry's never-ceasing effort to give better vision to the millions of Americans with defective eyes. Years of patient research, large sums of money, and the accumulated knowledge born of centuries of scientific investigation were poured into the solving of aniseikonia. And the same statement can be made of every important advance in optical science.

NEW types of lenses—the climax of intense optical research—play fantastic tricks with visible and invisible light. Polaroid lenses screen out the blinding and dangerous reflected glare so familiar to all who drive cars. And if your eyes are sensitive to excess light, your doctor can now prescribe for indoor or outdoor use absorption lenses that admit varying degrees of light, reduce glare, and absorb the potentially dangerous invisible ultra-violet and infra-red rays. (Ultra-violet causes sunburn while infra-red is heat radiation.)

These mysterious absorption lenses protect the eyes of welders and furnace and foundry men whose work is exceptionally eye-hazardous because of the glare and unseen radiation. Specially toughened lenses, some of them of the absorption type, have also been developed; and these lenses, strongly resistant to flying objects, annually save thousands of eyes in industry.

One of the great scientific contributions to spectacle precision is the development of Tillyer lenses. These lenses give clear vision to their very edges, and so enable defective eyes to see better with exceptional comfort.

Cataract operations comprise approximately 25 percent of eye surgery, according to a recent re-

port issued by a large eye hospital. This delicate operation consists of the extraction of the diseased lens from the eye. Scientists have designed special lenses to compensate for the missing eye-lens and these restore sight. For sub-normal eyes which are nearly blind, scientists have designed telescopic

Movie star Ida Lupino receives a demonstration on the ophthalmoscope, the machine which diagnoses reading ability

lenses with tremendous magnifying power.

Recent years have witnessed the development of new and improved eye-examining instruments which are even more dramatic than the new lenses. Some of these instruments assist the eyeman to determine the patient's eye errors and, equally important, provide clues to the state of his general health. The ophthalmoscope, for example, projects a beam of light into the eye and permits the eyeman to examine the retina and background of the eye—the only part of the body where arteries, arterioles, veins, and capillaries with the blood circulating in them can be viewed in their naturally living state. With the aid of the ophthalmoscope, symptoms of eye, brain, blood, and systemic diseases can be observed in the eye's background. Recently the instrument was improved by the addition of Polaroid material which eliminates the glaring reflections that formerly handicapped doctors when looking into the eye.

At the present time it is not possible to make an objective examination of diseased conditions along the retino-cerebral pathway. The nature and location of these conditions can only be inferred from an analysis of disturbances in the field of vision. Your field of vision is the extent of space seen while your eyes are looking directly ahead. Normal eyes see approximately 120 degrees in the vertical plane, and together 180 degrees in the horizontal plane.

Two optical instruments—the perimeter and stereo campimeter—are used by professional men to observe and chart changes in the field of vision. These field studies are now considered indispensable in the study of diseases of the optic tracts, brain diseases, and other pathological conditions which produce functional disturbances in vision. Through field studies, the development of such conditions are often detected long before they are observable by other means.

Night blindness—the inability of the human eye to readjust itself quickly to normal sight after exposure to brilliant light—has been studied intensely in recent years. All of us have experienced the sensation of temporary blindness upon entering a darkened theater from a brightly lighted lobby. Persons in normal health quickly readjust their sight. Those suffering from night blindness require a longer interval of readjustment before they can see in any darkened room. Interestingly, night blindness may be caused by a lack of vitamin A or by certain eye and other diseases.

To facilitate night blindness studies, Dr. J. B. Feldman, Philadelphia physician, recently developed an instrument to detect night blindness. The adaptometer partially bleaches out the visual purple in the eye, a substance needed for night vision, and the time required for the eye to regenerate its visual purple is the basis for measuring the degree of night blindness. Eye authorities now consider a night blindness test an essential precaution for motorists, airplane pilots, railroad engineers, and certain industrial workers.

It should be emphasized that scientific research inspired by a definite need, is the motivating factor behind the development of present eye-examining instruments. A case in point is the recent phoroptor into whose creation refraction experts, research scientists, engineers, and designers poured their respective talents.

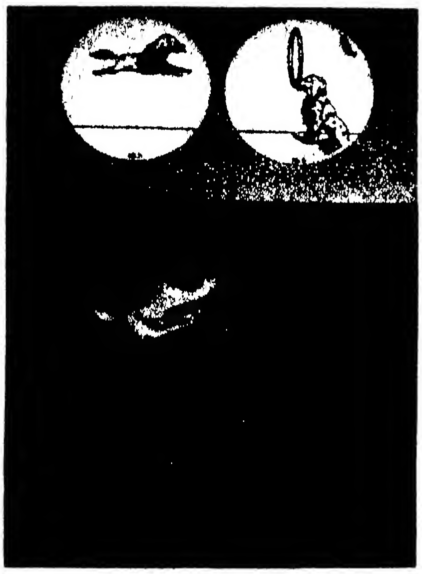
THE phoroptor, an optical miracle which literally dials your prescription, contains only 36 lenses, but these lenses can reproduce 61,060,386,816 different prescriptions for glasses! Heretofore, it was necessary to slip different lens combinations, by hand, into a spectacle frame until a satisfactory prescription for the wearer was found. The phoroptor performs the same task in a fraction of the time and with considerably greater accuracy. An ingenious mechanism within the instrument automatically adds up the individual lens

When the eyeman looks into eyes through the ophthalmometer, used to measure astigmatism, he sees striking designs (inset) on the eyes' corneas

powers and records the total correction on an indicator.

Another step forward in determining accurately the visual acuity of eyes was the development of a special projector, and special slides, designed to take the place of the old-fashioned test chart hung on a wall.

Your eyes are each equipped with six muscles which permit them to be turned in any direction or converged or diverged. These muscles perform a tremendous amount of work in the course of a day. More than 100,000 eye muscular movements are made by the average good reader in a single half-hour's perusal of non-technical material. Those of a poor reader may run as high as 300,000. If eye-coördination is below par, the attempt of the eyes to focus on



An eye muscle exercise used as a target in the stereo orthopter. Look between the two pictures and draw the page close to the face. The dog will appear to jump through the hoop

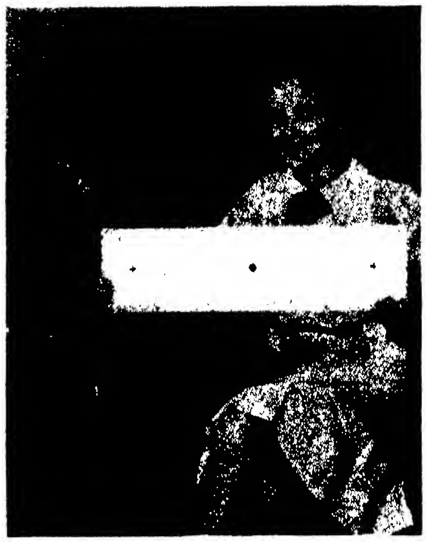
an object, and the brain to fuse the images, may cause eyestrain, headaches, or even cross eyes.

It goes without saying that eye muscles, like other parts of the body, may get out of kilter. This has long been a challenge to eyemen, and the challenge has been fairly met by optical scientists who have developed a unique device for exercising and training weak or lazy eye muscles. An almost automatic mechanism, the stereo orthopter forces the eye muscles to function correctly by means of a complicated arrangement of mirrors, lenses, lights, and stereoscopic images. Cases of squint, more familiarly known as cross eyes, formerly corrected only by surgery, have been successfully treated by the stereo orthopter.

Educators report that inefficient reading habits contribute tremendously to school failures. Of great importance, therefore, was the introduction, several years ago, of two instruments to diagnose and correct defective reading habits—the first scientific attempt to improve reading ability on a large scale. Essentially, the ophthalmograph is a motion picture camera which photographs light reflected from the eyes as you read. The resulting film, or reading graph, reveals, upon analysis, the nature of your reading habits, such as speed of reading, fixations, span of word recognition, and other data.

If your reading graph discloses defective reading habits, the metronoscope can be called into action. This instrument has three shutters in front which open and close in sequence, exposing words printed on a revolving reading roll. You are thereby forced to read correctly, for the operation of the instrument will not permit you to pause excessively long or to retrace in your reading. In addition, the roll can be speeded up, teaching you by degrees to increase your reading speed and improve the efficiency with which your eyes take in words or groups of words at a glance.

It is startling to learn that ophthalmograph reading graphs of over 5000 subjects of all ages, taken at random from various sections of the country, revealed that not more



The stereo campimeter, at left, is used to measure blind spots, while the chart is a simple test to show up blind spots

than 25 percent of them read with real efficiency. Obviously, a more effective approach to the teaching of reading is urgently needed.

In a review of the new instruments and lenses now providing better vision for those with defective sight, tribute should be paid to the many scientists whose ceaseless research has made them possible. This research never ends.

And during this year, perhaps, this inexorable march toward new frontiers in optical science will attain objectives now seemingly beyond realization—new lenses, new instruments, new techniques that may revolutionize present procedures completely. Such achievements are not impossible. The optical industry will see to that.

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EXTRUDED METALS

Process Common Abroad, Little Known Here

STAINLESS steel, nickel alloys, bearing steel, and non-ferrous alloys are now being extruded in the form of tubing, structural shapes, and rods as a result of notable developments in extrusion presses and metallurgical methods during the past five years, British engineer Albert B. Cudebec, recently told the Metals Engineering Division of the American Society of Mechanical Engineering.

Metal alloys which do not work well by rolling, welding, or piercing can now be economically extruded. "Several such alloys are being extruded in large quantities in Great Britain," Mr. Cudebec said, "but these have not yet been commercialized in the United States.

"Soon after the British defense program got well under way, the metal-extrusion process quickly became so vital to national-defense purposes that 40 or 50 of these large plants are now in production in Great Britain. Moreover, several plants for the British commonwealths are either in production or are now being rushed to completion.

"It is not definitely known how many of these plants were in operation in France before its recent collapse, or how many are in use

Ball bearings are automatically measured for size, roundness

in Greater Germany, but it is probable that several dozen of them are now operating upon a 24-hour basis. From these figures, one can visualize the probable expansion in extrusion plants which may occur in the United States before America's present national-defense program is completed.

"The extrusion process does not compete in the ordinary field of carbon steel and is only economically interesting in handling expensive ferrous alloys and all non-ferrous products. This field, however, is very wide as special alloys are now being substituted for heavier parts in almost every branch of mechanical-engineering design."

BEARING CHECKER

Automatic 'Umpire' Calls Bad Balls

A NEW automatic machine that checks, to millionths of an inch, the size and roundness of balls used in ball bearings is the latest guardian of accuracy on the Ford Motor Company's Rouge plant production line. The gage is primarily used to check the balls, $\frac{15}{32}$ of an inch in diameter, which are used in transmission bearings.

Operating in a glass-enclosed room at the end of the ball-bearing department, the automatic gaging device measures by electricity dimensions so small they almost defy human imagination. And after checking the balls, the gage sorts them in five different size classifications.

The gage is an ingenious device housed in a cabinet five feet high. Balls are fed into a hopper at the top and they drop into classified drawers in the base at the rate of 5000 an hour or slightly less than 84 a minute. As each ball is fed from the hopper into the gaging unit, it is held momentarily at a single measuring point. Before the machine is started, the operator makes four micrometer adjustments to the measuring "head" to establish the size desired for the ball. Only balls of one size are run at a time, so that the settings remain untouched during the run.

During the momentary pause of each ball in the measuring unit, it is checked for four dimensions—oversize, undersize, under-high limit, and over-low limit. If the ball is found to be in any of these categories, the gage head operates an electric relay to open one of four small trap-doors along a trough leading from it. An oversize ball, for example, will automatically open the trap-door that consigns it to the proper receptacle. Out-of-round balls are also automatically rejected.

When a ball of the right dimension drops from the gage unit, it rolls down the trough to the bottom without being caught by any of the four intervening trap-doors.

GLYCERIN

Synthetic Type Developed from Petroleum

A NEW and commercially practical way to make glycerin, important chemical raw material for nitroglycerin, was disclosed recently to the American Institute of Chemical Engineers. Dr. E. C. Williams, vice president and director of research for Shell Development Company, Emeryville, California, announced that his company already was operating a semi-commercial plant for making synthetic glycerin from petroleum.

In peace-time the largest use of glycerin is in the manufacture of alkyd resins for varnishes and lacquers, but appreciable quantities are used to impregnate materials such as Cellophane and parchment, to process tobacco, and to make nitro-glycerin for dynamite. During World War I, however, the British used huge quantities of glycerin to make cordite, a propellent powder similar to smokeless powder.

At present, glycerin is a by-product of the soap industry and the fat splitting industry; consequently, the supply of the chemical is dependent upon the activity of these industries. The price of glycerin has been extremely erratic, varying from 10 to 32 cents per pound in the past 20 years. The present price is around 12 cents. Due to war needs, the price rose to 70 cents per pound in 1917 and supply fell short of demand.

Chemically, the development of the process is one of the great achievements of this decade. Essentially, the steps in the process are as follows: Isolation of propylene, a gas, from petroleum (a well-known procedure); reaction of propylene with chlorine gas to form allyl chloride; reaction of allyl chloride with caustic soda to form allyl alcohol; and conversion of allyl alcohol to glycerin. An alternate synthesis may be used in which the third step is replaced by the formation of glycerin chlorohydrin instead of allyl alcohol.

PLASTIC TILES

Give Promise for Decorative Walls

SOME years ago we watched with interest the development of glass bricks for use not only as architectural trim but for making entire walls in buildings and homes. Similar use of plastic is forecast in a recent announcement of the makers of Lumitile. These tile-like hollow blocks are molded of Monsanto

Plastic tiles, light in weight, offer a range of decorative possibilities

A wall section of new plastic tile, translucent, with back lighting

Lustron, a relatively new polystyrene plastic.

So far, apparently, there is no intention of using Lustron tiles, or Lumitile, to make exterior walls, though the material is extremely resistant to water; and hot humid conditions will not affect its beauty or strength. Architects and designers, however, believe that the new material opens wide possibilities in decorating living and dining rooms, lobbies, reception rooms, and cafes. Beautiful color effects can be obtained, and it is possible to bring out these colors to best advantage in interior decorations by the installation of lights behind walls made of the material. One such decorative treatment, with back lighting, is shown in the photograph at the top of this column.

Lustron is a light plastic, so the tiles are easy to handle. In temporary walls or where the rear of the wall is accessible, the individual hollow blocks are simply fastened together with concealed bolts. In permanent installations, special cements are used, welding the individual blocks into one solid unit.

GOGGLE TEST

Machine Gun Determines Toughness of Glass

THE average compensation and medical cost for eye accidents in industry is almost twice that of other injuries. Because many of these injuries, resulting in the loss of eyes or the loss of sight, occur from flying chips, Bausch and Lomb technologists have devoted much attention to the development of hardened lenses which will withstand or break the shock of flying missiles.

By a suitable selection of glass and unique methods of annealing, a lens can actually be case-hardened by a uniform strain. Industrial goggle lenses are now made which will stand up indefinitely under a barrage of ⅝-inch steel balls, weighing 0.57 ounces, fired at a range of 40 inches under a pressure of 28 pounds of compressed air. This new machine-gun test, shown in the illustration, supplements the older drop test and closely simulates the effect of flying chips.

The process of hardening lenses has so improved that it is now possible to have a workman's prescription ground into these lenses. Previously it has been necessary for the workman to wear his regular glasses under his safety goggles.

WELDING SAVINGS

Can Help Open The Bottlenecks

THE machine-tool industry has been called the bottleneck of industrial production during our rearmament program for so long that people are beginning to believe it. The James F. Lincoln Arc Welding Foundation has seen fit to do something about this problem. It has made a study of savings in time and expense that may be effected by the use of electric arc welding. Those savings, according to the Foundation reports, amount to a reduction of more than 25 percent in machining time, alone, for a number of finished products.

Out of the 109 welding case studies made by the engineers, the Foundation reports on 15, of which we give one as a typical example. In making a drill jig for a tractor front axle, the welding cost was \$12.76 as against \$17.93 by the former method, and the amount of machining saved by welding was 27 percent.

ALUMINUM PAINT

Fine Finish Without Filler or Surfacer

IN THE manufacture of aluminum paints, the difficulty has been to secure one that would dry quickly yet carry film-value solids suffi-

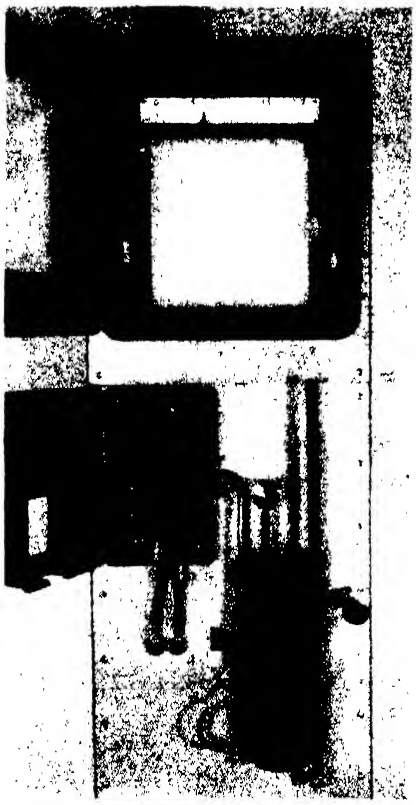
Industrial goggles withstand a barrage of steel balls

cient to give cast iron a smooth, fine finish without an additional filler or surfacer. The Red Spot Paint & Varnish Company has solved this problem in a new aluminum finish which was made particularly for the mechanism of a line of refrigerators. The development comprises primarily a new vehicle, plus the addition of certain other pigments with the aluminum. After development, the resulting coating was found to have good heat and grease resistance, and good color stability even in ready-mixed form.

WATER TESTER

Determines Dissolved Oxygen In Boiler Water

IN STEAM plant operation, one important source of boiler corrosion is the amount of dissolved oxygen in the feed water. Hence various tests and instruments have been developed for determining the amount of this dissolved oxygen.



Dissolved-oxygen recorder for measurements of boiler water

The Cambridge Instrument Company, Inc., has just announced a new dissolved-oxygen recorder which is sensitive to one part of oxygen in 400,000,000 parts of water. The water to be analyzed enters a cooler regulator where temperature is reduced to about 85 degrees, Fahrenheit, and maintained at that point. A constant-head device maintains the correct flow of water through a scrubbing tower of the analyzing unit. Hydrogen, generated in an electrolytic cell, flows to the scrubbing tower where it comes in intimate contact with the sample water. From this point on, the operation is essentially chemical, involving generation of hydrogen in an electrolytic cell; the water then dissolving some of the hydrogen and giving off part of its oxygen; the resultant mixture of gases diffuses to a meter block which contains sensitive elements connected in the form of a Wheatstone bridge. Action of the gases on platinum spirals causes an unbalance in the bridge circuit which is shown as a deflection of the recorder needle which, in turn, indicates the concentration of dissolved oxygen in the sample water.

BEAN OIL

Substitute for China Wood Oil

AMERICAN industry took another step recently toward achieving economic independence of foreign sources of raw materials; discovery of a substitute for China wood oil was announced by Pabco Industrial Research Laboratories.

The new substitute comes from an American bean, though Pabco does not as yet say just what bean. Advantages of the new development are lower cost; freedom from dependence on China's war-disrupted, tung-oil production; and more profits for the American farmers—estimated at twenty million dollars—who grow the bean.

Tung oil is used in making traffic lacquer for highway striping. In this one use alone there should be wide adoption of this substitute which can be sold for 13 cents a pound, whereas tung oil cost about twice as much in 1940.

TANK PROTECTION

Rupture Disks in Tanks Relieve Pressures

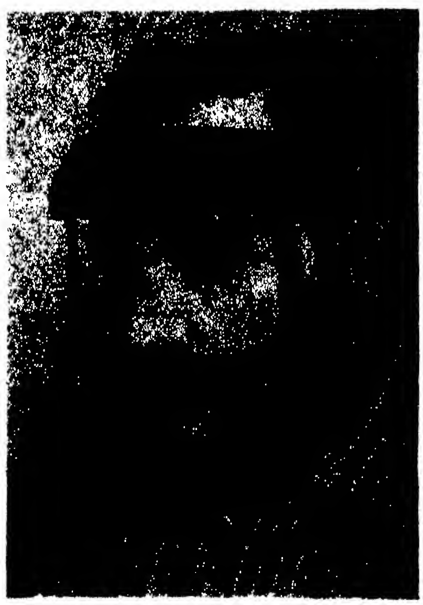
AN OKLAHOMA CITY engineer, Mr. Merl D. Creech, discussed recently before The American Society of Mechnical Engineers the fact that little work has been done toward safeguarding industrial pressure storage vessels against explosions. He said that even high-pressure air containers may often contain an explosive mixture introduced in the form of a small quantity of oil from defective compressors or by some faulty operation of equipment. Relief valves commonly used may take care of slow increases in pressure, but storage vessels are not protected from the rapid pressure during a combustion explosion of their contents.

Experimental work has been done with rupture disks mounted in the walls of such vessels. These disks would be made in large diameter of some relatively soft metal that is ruptured at a pressure point far below that of the bursting point of the vessel itself. Mr. Creech says that for the less violently explosive mixtures, a rupture disk of this sort will give absolute protection.

FACE SHIELD

Gives Protection For Workers

A NEW low-priced face shield for industrial workers has a plastacele window which hangs over the face like a small veil. It provides perfect vision, is flexible, gives good protection for the eyes against flying particles, and yet does not confine any portion of the face. This plastacele window, which is made in two sizes, is bound with flexible black binding and hangs from a broad head band of fiber.



Plastic face shield for workers

INDUSTRIAL TRENDS

INSTRUMENTS AND AIRCRAFT

As AVIATION goes, so goes many another industry; the electrical measuring instrument industry is no exception. When, back in 1888, a company was incorporated to manufacture measuring instruments invented by Dr. Edward Weston, powered flight by man was one of those things of which dreams are spun. In 1939, some 20 percent of sales of that same company were to the aviation industry; incomplete figures for 1940 indicate that this percentage will be exceeded.

Diversified uses of electrical measuring and indicating instruments give a broad field to this industry. Weston Electrical Instrument Corporation, alone, manufactures more than 600 different types, including such a wide range as voltmeters, frequency meters, ohmmeters, and wattmeters. With industry in general gearing up for greater production, more and more systems of automatic and remote control of processes will be developed and installed. Part and parcel of practically every such installation will be indicating and recording instruments of all types.

HEADLIGHTS TO PLASTICS

Remember the gas-operated headlights of early automobiles and motorcycles? Water dripping on a man-made stone produced the acetylene gas that, burned, furnished a lighting system of more or less reliability. Linkage between this cranky gas supply and industrial oxygen, plastics, safety glass, synthetic fibers, and a host of other modern developments may seem remote, unlikely. Typical of many industrial trends, however, the linkage is there, pointing the way to even greater developments for those who have the vision to see.

Again we go back to the last century for the beginnings of the story, this time to the Gay Nineties. The man-made stone was calcium carbide, product of the fusion of coke and limestone in the electric furnace. Short-lived, indeed, was the era of acetylene for lighting. The very force that gave birth to the carbide from which the gas was generated proved to be its successor. Electric lighting quickly supplanted gas. Under other conditions, the Union Carbide and Carbon Corporation might well have passed out of the industrial picture at this point. Research, however, as it has done in so many other cases, took hold and shaped the course of the future. Acetylene could be used for other purposes than lighting; burned with oxygen in properly designed burners, it found wide use in welding. By means of the oxy-acetylene torch, many industrial jobs could be done better than by other methods; new operations became possible that could be done in no other way.

From oxy-acetylene welding and cutting it was a logical step to investigating uses of oxygen itself. We can here pass lightly over the oxygen part of this story, since it was well told in the September, 1940, issue of Scientific American. Sufficient to say that oxygen now plays a substantial part in industrial processes not alone because of developments in technique but also because shipping problems were solved to the point where heavy pressure containers were replaced by tank cars and trucks that economically rushed liquid oxygen to consumption points.

Now the trend of this industry becomes clearer. Obviously, research in acetylene and oxygen uses would point the way to chemical applications of gases. Hydrocarbon gases, once obtained from acetylene but now to be had more conveniently from petroleum, are a fertile source of many organic chemicals that cannot be obtained economically from coal tar. From synthetic alcohols to solvents to ethylene glycol to a host of other synthetics goes the parade and, marching with these, go entire new industries built on research.

One of the turning points of the Union Carbide parade was the production of acetic anhydride, basic raw material for certain types of rayon, plastics, and film. Then came the vinyls, a chemical group stemming from acetylene and leading to, among other things, Vinylite, a plastic material of many uses. Here also started vinyl acetal, the plastic filler for safety-glass sandwiches.

Another branch of this parade of research is that concerned with iron alloys. Hark back again to the electric furnaces that first made calcium carbide. It is no wonder that the men who worked with these furnaces should become skilled in the manufacture of alloys that required tremendous heat for proper fusion. Hence the development of ferro-alloys widely used by manufacturers of stainless steels.

Largely a supplier to other industries for many years, furnishing the chemicals that would eventually reach the consumer in various forms, Union Carbide has followed a trend that has virtually forced it to become, itself, a supplier of consumer goods. Plastics for a multitude of purposes, textile fibers, safety glass, rayon, ethylene-glycol anti-freeze, all have changed the picture.

Beyond all this is the limitless chemical horizon. Plastics, ubiquitous though they may seem, are only in the toddling stage. Now Union Carbide is toying with a new process for obtaining phenol, basic raw material of one type of plastic, from hydrocarbon gases. Experimental work has been successful; only a definite need for a new source of phenol is required to press the button for commercial production.

COMPETITION FOR GLASS

Glass building blocks, widely used for architectural and decorative purposes, have a new competitor in a plastic tile that is light in weight, easily installed, translucent, colorful. This new tile, while it cannot be used as a structural member as can glass block, nevertheless can find ready application where colorful effects, combined with light-transmission properties, need not be combined with strength.

What effect this new Monsanto Chemical Company development will have on the glass-block business of Owens-Illinois Glass Company cannot yet be predicted, but past performance of Owens-Illinois in meeting competition can serve as an indication. Faced with inroads on the glass-container field, three metal-container companies were acquired; new outlets for glass containers in the food-packaging industry were developed; milk and beer bottles were improved. All of which is to the benefit of the consumer and to industry at large.

—*The Editors*

What is 'FM'?

Frequency Modulation Broadcasting Offers Improved Sound Range, Freedom from Noise

A. P. PECK

SINCE the first of 1941, broadcasting stations of a new type have been operating on commercial schedules in various parts of the country. Their signals can be heard only with special receivers. These stations employ the frequency modulation (FM) system first described in these pages in the May 1939 issue. Since that first description was published, experimental work has refined the system to a point where the Federal Communications Commission has given its blessing and sent FM out into the commercial world to make a living.

Boiling the whole thing down to the essence, we find that FM broadcasting, as compared with conventional or amplitude modulation (AM) broadcasting, differs in three important aspects. First, and possibly most important to the music lover, is a broadened range of tonal reproduction. Second is an almost total freedom from both natural and man-made static. Third is the lack of interference between transmitters operating in the same channel. This last point is not only important to the listener, who will not be troubled by heterodyne whistles when using an FM receiver, but has far-reaching economic aspects, as we shall see.

Before investigating in more detail the relative merits of FM and AM broadcasting, it would be well to point out the essential differences between the two systems. It has been said that many a good engineer has gone down to defeat in attempting to make the theory of FM easily understandable; thus we will make no attempt to delve into technicalities here, but will merely skim the surface.

As is well known, all radio waves have characteristics of both frequency and amplitude. The frequency of the wave is the number of times that it vibrates per second and is measured in cycles, kilocycles, or megacycles. Amplitude indicates the strength or intensity of the signal. Now, in order to transmit sound by radio, it is necessary that some characteristic of the wave be varied in accordance with that sound; modulated is the more technical word for "varied." That is, the sound to be transmitted is converted into electrical impulses and these impulses are used to modulate the radio wave. In conventional broadcasting (AM), the modulation circuit acts to vary the amplitude or strength of the radio wave, the wave staying at all times on the same frequency. In FM, on the other hand, the strength of the radio wave remains constant and the modulation circuit acts to vary the frequency.

It is all as simple—and complicated—as that.

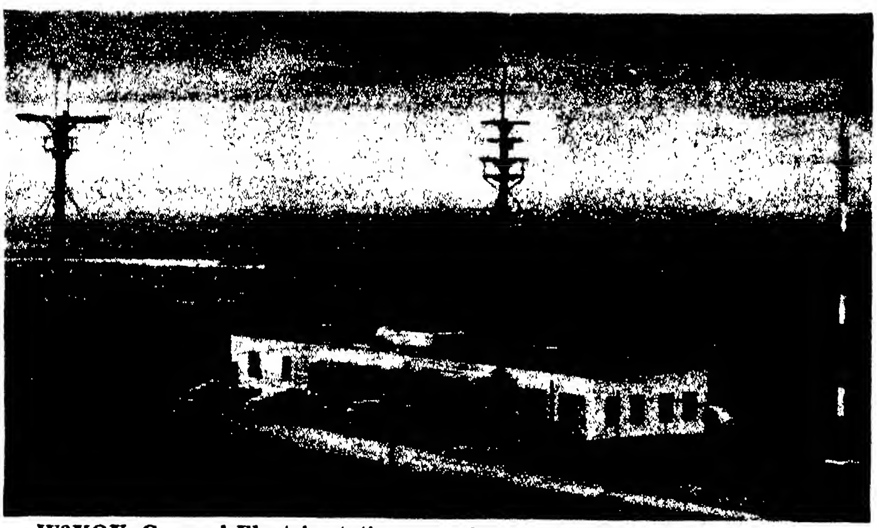
With this background, it becomes easier to analyze the three important aspects mentioned above. Tonal quality of any reproduced sound depends on the range of the sound from bass to the highest notes. Cut off the bass or the treble and quality is sacrificed. Cut off both and things become worse. The tonal range of the best AM transmitters and receivers is from approximately 100 cycles to 8000. FM equipment, on the other hand, will handle frequencies from about 30 to 15,000 cycles. (Do not confuse these cycles with those of the frequency of a radio wave. We are dealing for the moment with sound, which is far removed in the spectrum from radio waves.)

ANYONE familiar with the physics of sound and music will tell you that the basic notes of all instruments are identical; the overtones, echoes, harmonics are the factors that give rise to the complex patterns of sound which distinguish the oboe from the piano, French horn from the violin. The vastly increased frequency range of FM, therefore, opens new fields to music, making it possible to transmit and reproduce all the exquisite overtones and harmonic notes that give to music its color, resonance, depth.

Now as to freedom from natural and man-made static: True enough, a modern AM receiver has little trouble from such interference, at times. Brute force of high-powered transmitters, combined with sensitive receivers, permits reception at such low volume-control settings that, unless the static is very bad, no interference is experienced. With FM, however, no such combination is necessary.

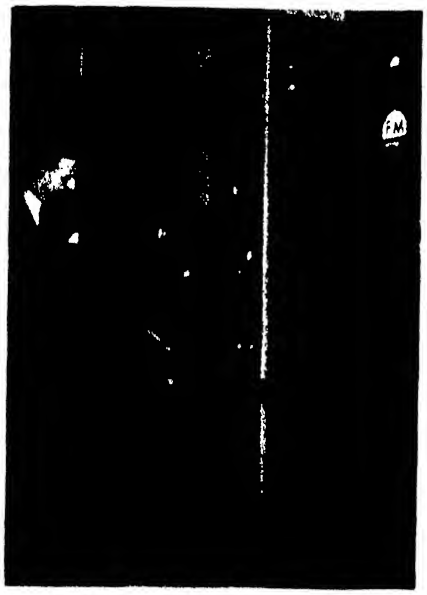
Lightning and electric razors, summer static and vacuum cleaners, automobile ignition systems and dial telephones all act as miniature (sometimes gigantic!) AM transmitters. Such are the characteristics of the FM receiver, however, that these impulses never get as far as the loud-speaker, hence are not reproduced; reception can go on during the worst barrage of interference.

The third virtue of FM—lack of



W2XOY, General Electric station near Schenectady, New York, used for both television and FM. At right is frequency-modulation antenna

interference between transmitters—is important to the ultimate use and success of the system. With AM transmitters it has been the practice to place them long distances apart when they are to operate in the same channel—that is, on the same frequency or wavelength. Alternatively, stations are required to share time, to use directional antennas, or indulge in some other form of co-operation or necromancy to keep down interference between stations. When two or more FM transmitters are operating on the same wavelength, however, the receiver automatically selects the strongest one; not a whisper of interference is heard from the others. Only where the receiver is located on the fringe of the service areas of two transmitters, where both signals are received with equal intensity, are there indications of interference. Here a simple directional receiving aerial will solve the problem neatly.



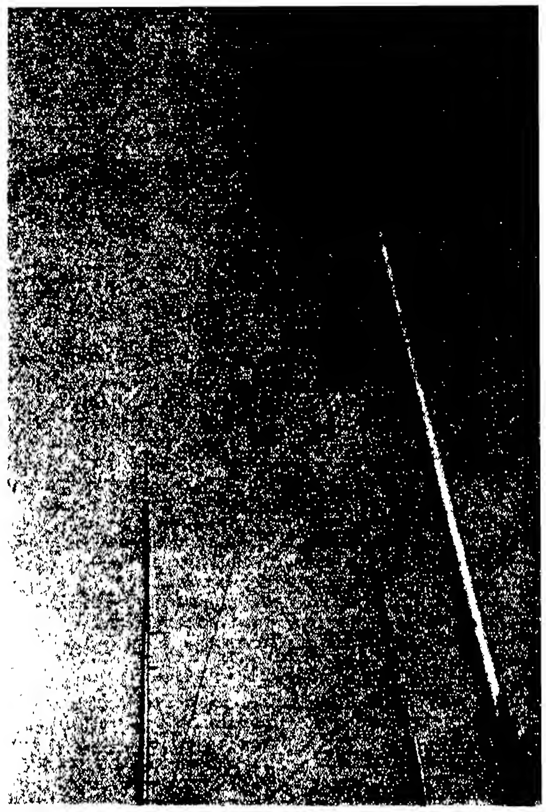
Transmitter at W2XOR, frequency modulation radio station

So far it would appear that FM holds the upper hand, but there is still one advantage on the side of AM that must not be overlooked. AM, operating in the conventional broadcast band, usually has a greater coverage area than FM. This is particularly true with high power. FM cannot approach the night-time coverage of a 50 kilowatt AM station operating on a "clear channel." Even the most powerful FM stations cannot reach out more than 100 miles with anything akin to constancy. This service limitation, however, is a characteristic of the high frequencies used for FM operation, rather than of the system itself. When AM is used in these same bands, FM proves superior. Thus we find many high-frequency police installations changing over to FM operation.

In all fairness to AM it must also be said that high fidelity of reproduction is not inherently a characteristic of FM alone. It can be had with AM, but not in a practical manner. Amplitude-modulation stations are assigned to channels with 10-kilocycle separation; true high-fidelity transmission would so widen the transmission band that there would be unmerciful interference between stations. Therefore AM, compelled as it is to observe legal limitations, cannot avail itself of its own possibilities and must, of necessity, get along as best it can.

It is obvious from the foregoing that an AM receiver cannot satisfactorily receive from an FM station, and vice versa. This has the effect of leaving the listening public out on a figurative limb. Will FM so soon replace AM broadcasting as to make obsolete all existing AM radio receivers? The answer is not quite as simple as the question. At the moment it appears that FM will fit into the radio picture in a logical, careful manner, there is no revolution, no wholesale junking of receivers in sight. It must be remembered that American broadcasting is an industry which has in excess of $75,000,000 invested in AM transmitting equipment alone; more millions are represented by existing receivers; still more millions are spent annually by the great networks. Investments and institutions such as these cannot be disrupted overnight.

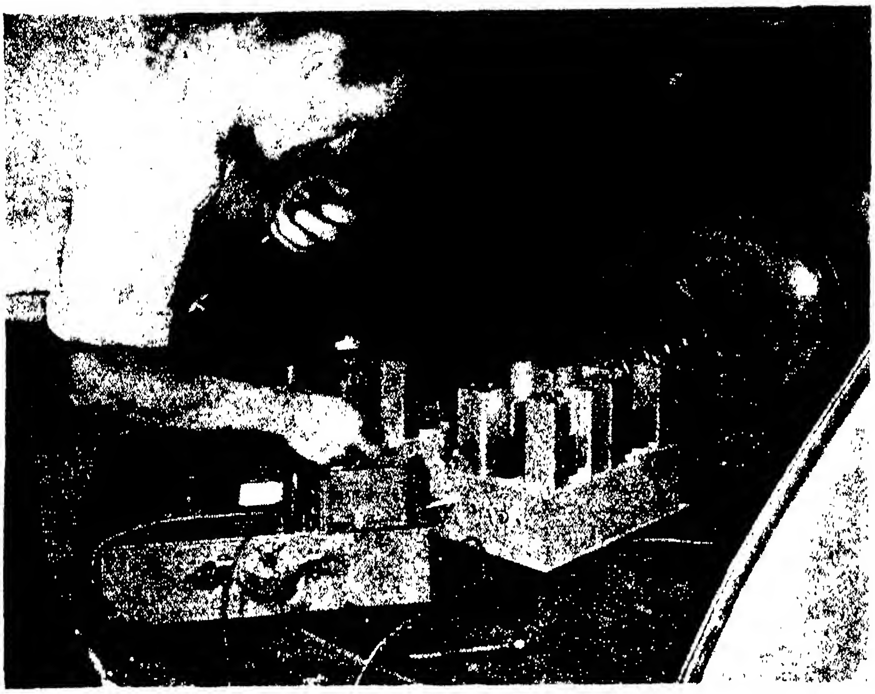
Where FM fits into the picture is in the "replacement market." This applies to transmitters and receivers as well. The receiver situation was well explained recently by Dr. W. R. G. Baker, of General Electric, in the following statement: "So far as FM receivers are concerned, we need only review the history of short-wave reception. First came the attachment which utilized our existing receiver, and finally the short-wave bands as they now appear on the modern radio receiver. It is not too much to expect that FM will follow the same path so that eventually the FM band will appear as a third or fourth band on the radio receiving set in practically every home."



Needle-like antennas atop a New York City skyscraper, used by station W2XOR for transmission of experimental FM programs

Already this prediction is coming true. It is possible to purchase an adapter for existing AM receivers, although it must be remembered that the high-fidelity characteristics of FM can be realized only with receivers of superior tone; the merit of FM may well be bottlenecked by a poor loud-speaker. In addition, several manufacturers are producing receivers for both systems; turn a switch and select FM or AM at will. These receivers fit perfectly into the replacement scheme, and will make the change-over process one of natural and normal absorption over a long period of years.

The economic significance of FM provides room for interesting speculation. No matter how we look at radio broadcasting as an entertainment, educational, or communicating medium, it must be admitted that its most important aspect is that of commercialization. Broadcasting stations compete for your attention and stand or fall in their chosen business by their degree of success in this direction. If you, as a member of the listening public, patronize the sponsors of programs over a certain station or chain, that station or chain will stay in business. If you don't, that station or chain will fail. Hence, in the past, the method of assuring commercial success has been to use such high power in transmission that you would find it easier to tune to a particular station and you become a member of its regular



Extensive field tests have been conducted in studying characteristics of FM transmission and reception. Here is a General Electric portable set-up that is carried in a car trunk. The transmitter is at left, receiver at right

audience. With FM, however, the picture changes. Governing regulations of FM transmitters will rate them on the basis of coverage area, not of power. Hence, tuning across the FM band, you will find that all stations in your service area come in with equal or nearly equal volume. You will, therefore, no longer tend to listen only to those stations easiest to receive, but will make your selection on the basis of program quality. This fact will naturally put strong emphasis on good programming, and we may well expect that future FM programs will be presented on increasingly higher planes.

It is expected that, by the time this article reaches the reader, FM service will be available in a dozen widely separated major cities. There are still, however, those who look askance at FM. They see it as a newcomer that will endanger the big business of broadcasting; they see the day when AM will be relegated to rural areas, with FM serving metropolitan areas exclusively. There are others, more far-sighted, perhaps, who see AM and FM developing along parallel paths, as parallel services to increase and enhance the wealth of education and entertainment available to the radio audience.

Both factions, however, must bear in mind that the listening public, not the engineers, will be the deciding factor. FM stations are on the air. They already have large audiences. If these people find in FM something desirable, better, more adapted to their wants, they will demand it. And that demand will be heard and obeyed. In the final analysis it must be remembered that the public made broadcasting possible; that same group will determine the fate of FM.

• • •

HALF SOLES

Invisible Joint Depends on Aluminum Last

You've probably seen signs advertising "Invisible Half Soles" hanging in shoe repair shops. Our curiosity finally beat us, accustomed as we were to a rough, ugly joint about halfway back on the soles of our re-soled shoes, so in we walked to ask about "Invisible Half Soles." We also walked into a peach of an aluminum story.

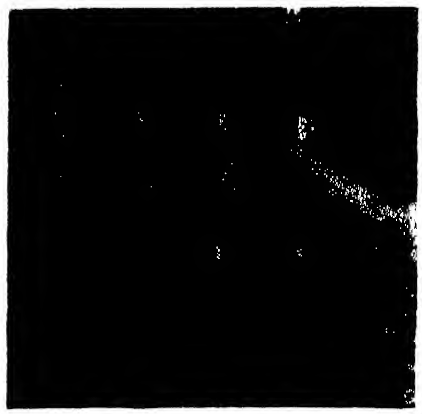
They are half soles and they are invisible, and there is a joint, but it doesn't show. But instead of the old, prominent stitching and nails, the new sole is applied by tough, weatherproof cement. Then the shoe is fitted with a scientifically designed aluminum-last body and sole plate which press the new sole tightly against the body of the shoe until the cement dries. The aluminum body and plate are carefully designed to retain the contour of the shoe and avoid changing the comfort of a pair of broken-in shoes.

These plates and bodies are part of the complete Shoepress System, developed by The Shoe Press Corporation. Aluminum is used because of light weight and its ability to withstand the strain imposed on the gooseneck of the body when in the press.—*Aluminum News-Letter.*

SHOCKLESS FUSE

Cartridge Type Fuse Simplified, Made Safer

From the laboratories of the Warren Lamp Company comes a new renewable cartridge fuse which may be inserted or removed without the use of fuse pullers. Its primary difference from standard fuses is its lack of ferrules on the ends. A tough casing of hard fiber,



No shock from new fuse

comprising the body of the fuse, extends all the way from one knife edge to the other, eliminating possibility of shock when removing fuses. Furthermore, the construction of this fuse is simplified as it has only two main parts besides the renewable link.

ACID-RESISTANT ENAMEL

Chemically pure acetone kept at the boiling point day and night for over six weeks would, one might think, destroy the surface of even the best enamel. Such is not the case, however, with Devilac Bake Enamel, for exactly that kind of test has been run by the manufacturer—may still be running for all

we know—and no change in the glossy film surface has been noted.

Devilac enamels have been developed especially to resist concentrated sulfuric, nitric, and hydrochloric acids, as well as alkalies and gases. The air-drying types dry in less than 10 minutes, while the bake types require either 30 minutes at 250 degrees, Fahrenheit, or 20 minutes at 275 degrees, Fahrenheit. It is claimed that they are resistant to all the chemicals mentioned above, and that neither the original hardness nor the color changes under their influence.

LINEN FOR DEFENSE

There is a great deal of talk about this or that material being a national-defense essential, yet most often these materials simply enter into the industries which prepare totally different kinds of products in the defense program. Linen might at first glance be considered as one of these. Yet it is actually vital to a piece of equipment very necessary in military operations, linen is used in making the cords for parachutes.

Normally much linen is imported, but since the supply from such countries as Belgium and the Baltic states is shut off, American farmers have increased their production of the fiber. Particularly in Oregon, Washington, and Michigan, has the production of flax gone up—to a point almost double normal production. We do not quite produce all the fiber flax required, but, to help make up for this deficiency, the U. S. Department of Agriculture reports that a heat-resistant type of cotton and other substitutes have been found satisfactory for certain purposes in parachute rigging.

NEW PLASTER

Of Magnesium Sulfate, Is Stronger

Though chemically the same as plaster of Paris, a new gypsum plaster, described recently at a meeting of the American Institute of Chemical Engineers, is about twice as strong as the old-fashioned article. In fact, it approaches Portland cement in strength.

The new product was announced by E. P. Schoch and William A. Cunningham of the University of Texas. It is prepared, they explained, by heating gypsum in a magnesium sulfate solution, whereas plaster of Paris and ordinary wall plaster are made by the dry calcination, or burning, of gypsum.

Experiments in a small pilot plant indicate, they stated, that it can be made at a cost of $8.82 per ton, a figure that may be reduced by large-scale production. Probably the magnesium sulfate plaster will find its chief application in wall board, tile, and other factory-cast products.—*Science Service.*

HAND ELECTRIC TOOL

Delicate carving or engraving may easily be done by the Whiz electric tool produced by Paramount Products Company. This light-weight tool has a pistol grip

Multi-use hand tool

and may be had in either single-speed or two-speed models. A large cooling fan in the motor prevents overheating when the tool is used constantly. A flip-over switch is conveniently placed under the thumb of the user.

For use with this handy device there is a vast assortment of small grinding wheels, steel burs for carving, drum sanders, saws, polishing wheels, cutting disks, and brushes. Drills in sizes from 1/16-inch to 3/16-inch are also available.

CROSS-EYES

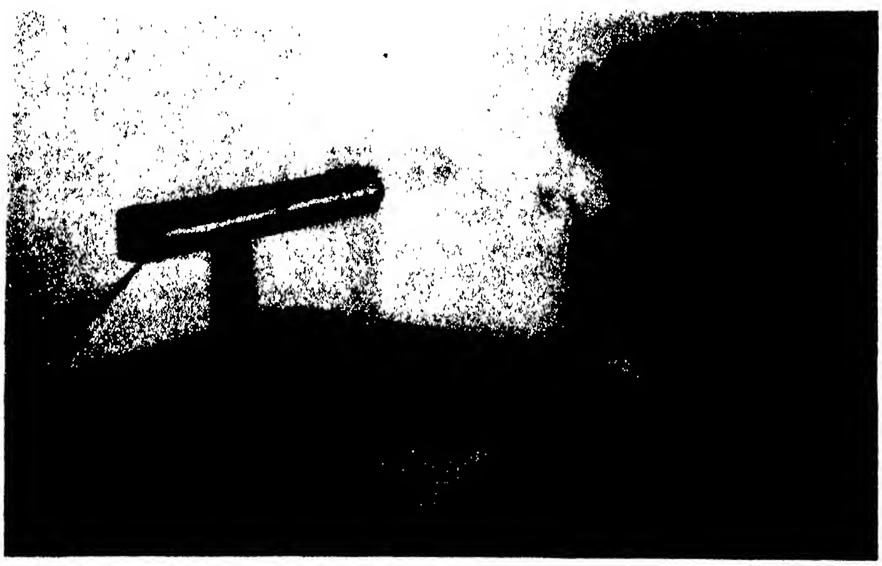
Device Shows Whether Treatment Will Succeed

The perplexing problem of deciding the possibility of treating cross-eyes successfully has been solved by the development of a new testing device, first of its kind, which determines in advance of treatment whether the eyes of cross-eyed persons can work together as a unit after they have been straightened by eye-muscle exercises or surgery.

The new instrument, announced by Dr. J. F. Neumueller, whose article on eye-science appears on page 89 of this issue, requires only a half minute for the diagnosis, and its performance is based on the phenomenon of the after-image—the sensation of seeing an image after the stimulation causing it has ceased to exist.

The after-image tester consists of a glass tube containing an electric wire. The current is switched on and as the wire glows the patient looks through only one eye at a red dot on the center of the tube. The tube is then turned from its horizontal position to a vertical position and the patient peers at the red spot through his other eye only.

Then the light is turned off and



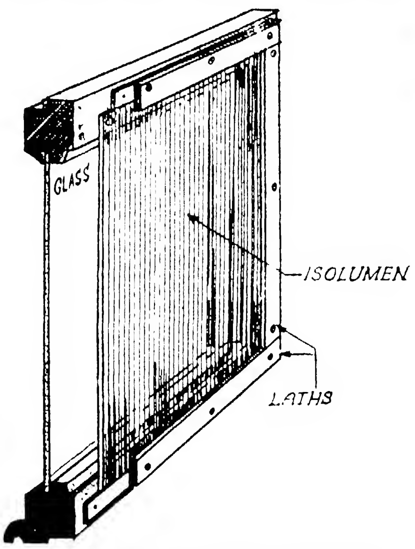
After-image phenomenon determines desirability of cross-eye operation

the patient, both eyes now open, looks at a fairly bright wall. Soon he notices two dark lines, the negative after-images. If these two lines form a cross, his cross-eyes can be successfully treated. But if the two lines do not meet, the chances of restoring binocular vision are remote.

BOMB-RESISTANT

Plastic Sheet in Windows Resists Bomb Concussion

BECAUSE the concussion of bombs falling on London smashes windows over a very wide radius even when there is no actual damage from bomb splinters, many people have wondered how Londoners will keep warm this winter and at the same time get some daylight into their



Isolumen sheets reduce window damage from bomb concussion

homes. A number of measures have been taken to care for this situation, but one of the most interesting is the use of a new type of plastic sheet called Isolumen.

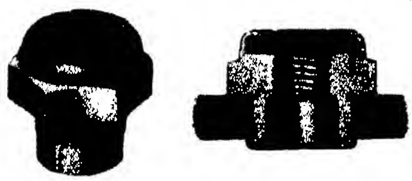
Isolumen consists of a corrugated transparent sheet sandwiched between two clear acetate sheets to make a product very similar in construction to our ordinary corrugated packing cardboard. The corrugated construction provides not only strength and rigidity but also air chambers which enable the slab to act as a thermal insulator. There is no fibrous or metallic reenforcement, and the plates have self-supporting stability against wind or snow pressure, though the material is not as rigid as glass plates. On the other hand, it is considerably lighter than glass.

Whether a window pane has already been smashed or not, the Isolumen sheets may be attached to the window frame by a simple arrangement of laths tacked in place. Besides providing for the transmission of daylight and insulating against heat loss, this sheet gives protection aganst flying glass and even against bomb splinters. Concussion due to a bomb would probably lift it as a whole from the window frame, but the elasticity of the plastic would cushion the force.

ELASTIC NUT

Knurled-Shank Clinch Type Is Self-Locking

FOR fastening sheet-metal assemblies in which the parts must be readily removed and returned to position, a clinch type of self-lock-



Unthreaded fiber collar locks screw, takes up thread play

ing nut with knurled shank is offered by Elastic Stop Nut Corporation.

To install the nut, a hole is drilled in the structure and the shank is pressed into the hole. The mouth of the shank is then spread against the back of the structure to effect a clinching hold. The knurling engages the drilled surface and thus assists in eliminating any turning of the nut.

The head of the nut is fitted with the vulcanized fiber collar which characterizes all types of Elastic Stop Nuts. This collar, being unthreaded, resists the entrance of the screw, thus automatically taking up all thread play and bringing the load-carrying thread faces of nut and screw into a tight pressure-contact.

CATTLE FOOD

Urea Useful in Cattle Ration: May Mean Savings

UREA, a simple nitrogen compound hitherto used principally in fertilizers and plastics, can be mixed with cattle feed as a substitute for more expensive sources of nitrogen, nutrition researches at the University of Wisconsin indicate.

Comparative feeding experiments, conducted by I. W. Rupel, G. Bohstedt, M. I. Wegner, and E. B. Hart, showed that groups of cows receiving urea as their principal source of nitrogen produced as much milk as similar groups which got their nitrogen in the form of the much more expensive linseed-oil meal.

The experiments lend support to the theory that bacteria in the digestive tract of cattle assist in their nutritional processes. When natural stomach juices from the animals were mixed with urea and cattle feed, under proper chemical and physical controls, as much as 95 percent of the urea disappeared, to reappear in the structure of bacterial cells.

WIROMETER

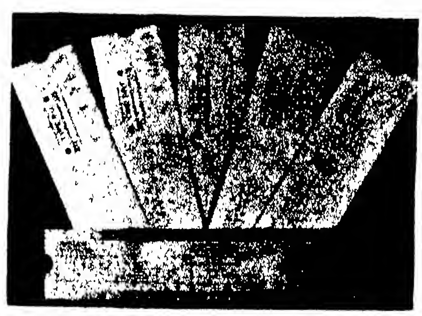
For Computing Common Wiring Problems

A POCKET-SIZE wire calculator, called the Wirometer, for use in computing wiring problems in accordance with the latest National Electrical Code, has been announced by the General Electric appliance and merchandise department. The Wirometer provides a quick method for arriving at code requirements.

Information which may be obtained quickly by the use of the device includes: conduit fill of all approved types of building wires, including wires of different sizes in one conduit; current capacities for wires when more than three wires are run in one conduit; corrections in current-carrying capacity for ambient temperatures over 30 degrees, Centigrade; and voltage drop for eight distribution systems.

The Wirometer is 8 inches long, by 2⅜ inches wide, and is made up of two sliding celluloid covers and six interchangeable cardboard slides.

Still another slide-rule type of wire calculator is of durable cardboard, with an inner slide, made by the General Cable Corporation. Both sides of this calculator are slotted to read, in three different



For determining wire data

holes, data printed on the inner slide—one side being for new work and the other for rewiring. Data obtainable are current capacity, size and type of wire, and conduit size. A temperature correction is also given on each side.

SOUND-PROOF

Room Not Sealed

From the Outside

OUT in East Springfield, Ohio, there is a new listening laboratory in which the sound of your own breathing resembles that of a small air bellows, and the snap of your fingers sounds like a pistol shot.

It is used as a sound inspection chamber for household refrigerator units.

This new laboratory of the Westinghouse company is the only sound-proof chamber in the world which is not completely sealed from the outside when in operation. Therein lies its unique character. In construction it resembles a labyrinth, or maze; it consists of a series of winding passages with 90-degree and 180-degree turns. Near the middle of these passageways is the actual sound-proof chamber, a 21,000-pound "floating room," which is supported in the air by 20 steel springs.

The winding passageways act as baffles to destroy reflected sound waves. But in addition, all walls of the labyrinth are covered with soft padding to absorb sound waves.

HEATING

"Reverse" Air Conditioning

Now Used in Office Building

HIDDEN units of heat extracted from cold outside air and water soon may provide a new source of low-cost heating for the modern home.

Final tests of a plant to "reverse" air conditioning were recently made in a new two-story office building of the Ohio Power Company in Coshocton, Ohio. Cold well-water, used to cool the building in summer, will supply winter heating when a switch is thrown. The reverse cycle refrigeration process which makes this possible has been developed at the Springfield plant of the Westinghouse Electric & Manufacturing Company, as discussed in our pages some years ago.

There is heat in everything—

even down to 459.6 degrees below zero, Fahrenheit. The air in an ordinary-size room at 32 degrees, Fahrenheit, still contains over 1300 hidden units of heat. If they could all be extracted from the air, these heat units would be able to melt a six-inch cube of ice and bring the water which resulted to boiling point.

In the Ohio installation, "refrigerated heat" is taken from cold air by a process which literally puts a refrigerating system "in reverse." First, well water is drawn into the system at the rate of 80 gallons a minute. Heat units are extracted from the water to heat the building, thus making the cold water colder. These heat units heat water in a condenser used to warm the air in the building, while the cold water goes outdoors to "warm up" again. In summer, the well water is heated with heat units extracted from inside the building and is then thrown out to "cool off."

"JACK-HAMMER"

Electric Hand Tool Makes Hammered Metal

Especially well received by our readers was our discussion of the Handee electrically powered hand tool for all kinds of grinding and

Leather-working with the new electric reciprocating hand tool

drilling operations. The producer of this efficient tool now announces a reciprocating plunger type of tool, called the Handee Artizan. The tool, held in the chuck of this machine, instead of rotating, delivers perfectly graduated blows to the work at the rate of 800 times a minute.

With the Artizan, small saw-blades may be used to do a job equivalent to that of a jig-saw. Or, again, files may be attached to do some types of filing jobs. Other pointed or knob-ended tools can be used for leather-tooling or for what the manufacturers call hammer-smithing of metal. For the

Electric hammer-smithing of metal opens new hobby fields

hobbyist these last two uses might prove the most fascinating, for a tool especially designed for metal working can be used to make all manner of small hammered metal objects such as trays, plates, candlesticks, and the like.

SHIFTING TRUCK

For Shuttling Railroad Cars

Occasionally, in an emergency, motor trucks have been used in freight yards to shuttle cars. At the Pacific Coast Terminals of New Westminister, British Columbia, is a large Mack truck whose sole job is that of shifting freight cars. It travels on the floored areas of the yards, and can move as many as six loaded freight cars at a time, or a load of no less than 420 tons.

This truck carries a ballast of five tons of lead and is equipped with a sub-frame to which front and rear bumpers are attached. The sub-frame is bolted to the regular chassis frame by means of rugged gusset plates. The bumpers are mounted on heavy springs so that in bumping and pushing the heavily-loaded cars there is no shock to the chassis. Likewise, the tow-hooks used for pulling are spring-mounted.

This Mack, with a three-man crew, can switch approximately twice as many cars in one day as can be accomplished with an ordinary switching engine and a crew of four.

COLCHICINE

Of Dubious Value in Animal Experiments

Striking results reported by plant scientists in treating plants with the chemical colchicine, have led many laymen to speculate as to whether the method has parallel possibilities in the animal world—whether the chemical tinkering with hereditary makeup of cells can be extended to animals, even perhaps to mankind.

In a review of the short history of colchicine technique, Haig Dermen of the U. S. Department of Agriculture, writing in the *Botanical Review,* makes clear that the prospect of advances in the plant-breeding field is much brighter than with animals. The first experiments with colchicine, in 1934, were in connection with animal

Lead-ballasted motor truck takes over a locomotive's work

tissue, and proved deadly to the animal cells, which degenerated and did not reproduce. One of the first experiments was an effort to kill cancer cells. By 1937, plant scientists, following with somewhat similar treatments, found that plant cells when treated at favorable stages and with suitably weak solutions not only doubled the number of their chromosomes but were able to resume growth and reproduction.

The difference in the response of cells in plant and animal tissue is so marked, says Doctor Dermen, that colchicine experimenting by amateurs is *definitely dangerous*. A minute quantity of the solutions used on plants might cause blindness if it reached the eye, or might cause skin irritation if carried to the face.

It seems evident, says Doctor Dermen, that plant treatments, for the present, offer a much more promising field.

COLOR-BLIND FLYERS

In Demand Now: They See Through Camouflage

For years Uncle Sam has been turning away color-blind flyers who wanted to go through the Army Air School at Randolph Field; now he is looking for them, according to *Ethyl News*. It has recently been discovered that camouflage, so successful in hiding guns and barracks from enemy aircraft, doesn't fool a color-blind man the least bit. He can see right through it.

The answer is, of course, that camouflage is almost entirely a matter of color—airplanes, for example, will be painted ground-color on top and sky-color on the bottom. Yet to any one who sees everything as various shades of gray, the familiar outlines remain unchanged. Even a thin screen of leafy branches does little good.

The discovery was made by accident at Fort Sill, Oklahoma, when the Army was testing the effectiveness of camouflaging heavy guns so they could not be spotted from the air. A regular air corps observer picked out 10 of the 40 guns which had been disguised. An observer from the field artillery picked out all 40—and confessed, after landing, that he could not distinguish one color from another. The answer was of course that he was color-blind.

According to the commandant

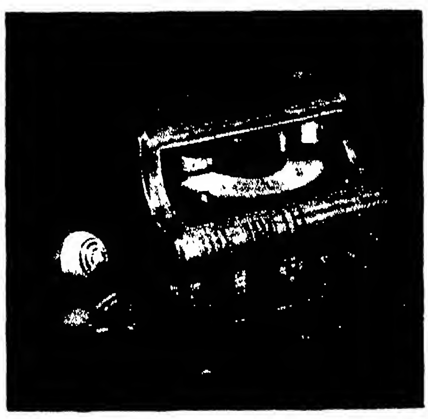
of Randolph Field's school of Aviation Medicine, this chance discovery suggests that a totally new scheme of camouflage will have to be developed for guns, airplane hangers, fuel or ammunition dumps, and other strategic objectives.

DICTATING MACHINE

Makes Use of Electrical Recording Principles

The SoundScriber Corporation has announced the production of a new type of dictating recorder using wafer-thin alloy disks. It is light in weight, has low operating cost, and can record conferences. The set consists of a recorder with a microphone, and a transcriber.

The disk, one of the most interesting features, is of a metal alloy, 0.006 of an inch thick and seven inches in diameter, and is practically indestructible. It can be dropped, bent, and written on without destroying the sound tracks. Fifteen minutes recording is obtained on each side, or one half hour per disk, by the use of low turntable speed and close groove spacing. A carton of 100 disks—which stack to a height of only 0.6



Compact recording unit and microphone of dictating machine

of an inch—thus contains 50 hours of recording capacity. The disk can be filed like a letter or mailed without special packing, and weighs only one-third of an ounce.

The microphone can record a whisper, or all the voices at a conference up to a distance of 20 feet.

The dictating recorder has a seven-inch turntable, and the recording head is equipped with a permanent diamond-tipped needle embossing the sound groove in the disk without chips or shavings. This unit also includes a built-in loud speaker and play-back head with a permanent sapphire-tipped

Seven-inch dictating disks

needle. Dictation may be instantly played back on the same instrument by simply turning a control which automatically lifts and locks the cutting head while the disk is being played back.

The transcriber contains the play-back features of the recorder, but it also provides a gooseneck "soft-speaker," audible only at the secretary's ear.

GUM IMPORTS

Industrial Essentials Still Come In

In spite of the fact that the war has disrupted shipping of many types of essential materials into and out of this country, *Chemical News* recently reported that the outlook is favorable for the continued shipment of gums from the Far East and central Africa. They report that gums will continue in sufficient quantities to meet the requirements of American industry.

Congo gum formerly entered the United States by way of Antwerp but is now coming directly from Africa. This gum is an important natural resin for use in oleo-resinous varnishes of all types.

There seems also to be no shortage of other natural gums, important for varnishes, which are imported regularly from the Netherlands East Indies. This is reflected in the prices which jumped upward when the war began but are now sufficiently low to stimulate a further increase in the use of these natural gums.

PLANETARIUM

"Vest Pocket" Installation Does Full-Size Job

A ten-cent mirror, electric clock motors, and a radio switch are the basic parts of a new invention which is a sort of "vest-pocket" planetarium. It had its preview some time ago in the Berkshire Museum at Pittsfield, Massachusetts. Called a "Stellarium," the

machine was built at a total cost of $250 by three young electrical engineers, Willard F. M. Gray, Stephen C. Leonard, and Guiles W. Bradshaw.

In the natural history room of the Museum is a small drum, two and a half feet in diameter, containing all the mechanism. From this are reflected the pictures of the heavens. They are slides of star maps made by Stewart Greene of the Museum staff, which are both scientifically accurate and extremely effective artistically. The maps are flashed from a mirror onto a flat ceiling by an air-cooled projector with a short focal-length lens. Ingeniously contrived so that they revolve, showing the heavens at any given date, the star slides also move back and forth, permitting the placing of constellations at any given point. Inexpensive electric clock motors move the projector for the planets. The entire mechanism is run by remote control.

This unique machine can do almost anything in its scale that the Hayden Planetarium can — and more. For example, it shows the planets enlarged, the moon in its various phases, and a total eclipse of the sun with the corona appearing.

VERTICAL FILING

System Eliminates Cabinet Troubles

A NEW method of vertical filing has been introduced, in the "Pendaflex" line, by the Oxford Filing Supply Company. This system consists, principally, of a method of holding the letter folders vertically within the filing drawer. In order to achieve this, a simple steel frame is inserted in any letter- or legal-size drawer. The two upper side-bars of this frame act as runners or slides for the ends of hanger rods mounted in both upper edges of each "Pendaflex" filing folder. These hanger rods are hooked to engage the side-bars positively.

In the new filing system described, folders are equipped with hooked hanger rods that engage side bars, holding the folders always vertical. Folders are easily removed or replaced

Use of this new system eliminates the follower block, prevents the inconvenient jamming of fat folders, and never runs into the difficulties encountered when folders fall forward or backward.

CATTLE TB

Bovine Tuberculosis Now Practically Wiped Out

BOVINE tuberculosis is now practically eradicated throughout the United States, the U. S. Department of Agriculture has announced. The last two counties, Kings and Merced, in the last state, California, have completed their testing and re-testing for infected cattle, and now every county in every state in the Union has fewer than 0.5 percent of its cattle infected.

The campaign has been going on for 23 years, in the course of which more than 232 million tuberculin tests and re-tests have been made, and about 4,000,000 tuberculous cattle detected and removed for slaughter.

This does not mean, it is pointed out, that nothing further remains to be done. Re-testing is still called for, especially in herds from which tuberculous animals have been removed in recent years, to prevent re-infection and a new spread of the disease.—*Science Service*

"MYSTERY" GUNS

British Lead; We May Have To Follow

BRITAIN'S new "mystery" anti-aircraft weapons, reported as filling the air with strange noises when Nazi planes try to pass overhead, have started a grand guessing game among ordnance men in this country, according to *Science Service*. Since it is admittedly just about impossible to describe anything merely from the sound it makes, the guesses do not pretend to be more than that—just guesses.

Most plausible would seem to be the one about the sound described as "a heavy single explosion disin-

THUMBS UP!

"If you have readers who would care to post me used back numbers of Scientific American," writes a reader from the "edge of the gun barrage" in London, *"they would be appreciated and passed on to our soldiers, thus helping to a community of ideas between our two countries.*

"Cheerio! Thumbs Up!
F. J. Young
5 Forest Drive,
Theydon Bois,
Essex, England"

(Any reader wishing to make this friendly gesture may forward copies to the address given above. Postage on Scientific American going to England is at the rate of 1½ cents per ounce.)

tegrating into staccato cracks high up in the heavens." This sounds as though it might be a large-caliber shrapnel projectile containing explosive bullets or small shells instead of the conventional pellets of ordinary shrapnel. Fired at a mass formation of bombers, a shrapnel shell of 6-inch caliber (or even larger) could create a menacing cone of danger that might force the plane formation to break up, even if it did not immediately destroy any of them.

A second weapon, described as making a flat roar striking a ceiling several miles up and then bumping along the top of the sky, may possibly be a rocket. Military rockets make a peculiar flat roar; the "bumping" effect heard on the ground may simply be echoes of the explosion reverberating, thunder-like, from the clouds.

The third weapon, nicknamed a "carpet-slipper machine gun," may be nothing more mysterious than a machine gun equipped with a muffler or a Maxim silencer, which removes most of the bark (though none of the bite) from single-shot firearms.

The fourth, which is said to have no more noise than the "frou-frou of a taffeta gown," seems to be nobody's guess. What is any honest ordnance man to think of a weapon that doesn't make even the suggestion of a bang?

Since the four sounds described seem to be in a descending order of noisiness, is there, perhaps, still another, a fifth weapon that operates in absolute silence?

ANTI-OXIDANT

Vitamin E in Animal Fats "Keeps" Them Longer

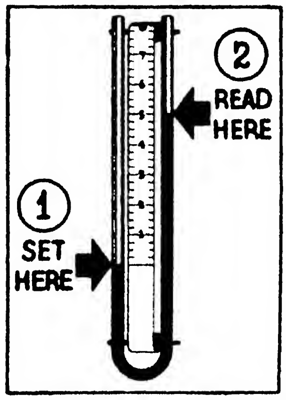
ANIMAL fats and oils, such as lard and cod-liver oil, tend to become rancid easily. On the other hand, vegetable oils such as cottonseed and wheat germ oils may be stored for long periods of time and yet remain perfectly fresh and stable. The vegetable oils but not the animal fats are rich in vitamin E (tocopherol).

When vitamin E is isolated in its three pure forms (alpha, beta, and gamma tocopherol) and added in small amounts to animal fats, it acts as a stabilizer (anti-oxidant) for these fats. That is, lard containing the vitamin remains fresh much longer than lard having no added vitamin E. Evidently, the presence of vitamin E, and possibly other as yet unknown stabilizers in vegetable oils, contributes to their excellent keeping qualities. When the vitamin is removed from the vegetable oils by various means, the recovered oil has the behavior of an animal fat.

MANOMETER

Direct-Reading By Simple Setting

EXPERIMENTERS and researchers using ordinary manometer tubes usually have two readings to make, and must subtract one from the other in order to learn the true difference between the height of liquid in the two legs of the U. A new direct-reading, U-tube manometer,



Help for the laboratory worker

developed by Trimount Instrument Company, permits a simple setting of a graduated scale so that the difference is read directly.

Between the two legs of this manometer is mounted an "endless-belt" flexible-steel scale operated from the side. When a reading is desired, the technician rolls up this tape until the zero point is opposite the lower surface of the liquid. The reading on the steel tape opposite the upper surface of the liquid in the other leg of the tube is the exact difference between the two levels.

WHEELS

The Nation Rides, And Depends on Them

IN ONE generation the American people have taken to wheels. But definitely!

As recently as 1915, a motor trip was an adventure. In 1940, some 1,000,000 farm motor trucks brought crops to market; 86,000 baking trucks delivered baked goods to American homes; 20,000 trucks delivered coal and oil; 100,000 "fire engines" were motorized;

12,000 police cars patroled city streets; 4,000,000 children rode to school daily by motor bus; 26,000,000 people got their RFD mail by motor car; 7000 public health nurses traveled by automobile; and even the steam railroads operated 1800 motor buses over 45,000 miles of highway route! In addition, the railroads employed 63,800 motor trucks for station-to-door deliveries. Topping all, 600,000 vehicles of the trucking industry transported countless tons of freight over the nation's network of highways and byways.

DWARF APPLES

Dwarf apple trees seem to be gaining rapidly in favor as attractive ornamentals. This fact is of no interest to the commercial fruit grower, but the amateur gardener will be pleased to learn that these may now be obtained from nurserymen.

These dwarfs do not grow taller than a man can reach; they bear fruit the first or second year after planting; and are especially well suited for training to special shapes. In reporting these facts, the New York State Agricultural Experiment Station adds the thought that often the bloom alone is sufficient to repay the planter for his time and labor.

PLASTIC MOLDING

Alloy Makes Harder Dies After Hobbing

Quantity production of intricate plastic parts has been considerably simplified since the introduction of "Plastalloy," a nickel-alloy steel produced by Henry Disston & Sons, Inc., in Philadelphia.

A large proportion of plastic molds are made by the "hobbing process," in which a hardened steel master hob, the exact shape of the finished plastic piece, is forced into a block of soft "hobbing" steel to a considerable depth. The resultant mold is then carburized and hardened. The hobbing steel must obviously be as soft as possible, extremely clean and sound to avoid any chance of pits, cracks, or inclusions on the face of the cavity, and it must case-harden well.

Until a few years ago it was common practice to use for this purpose a very low carbon "ingot iron," but when industry began to demand larger plastic parts in great quantities it became apparent that such molds would not stand up in service. They either wore out very quickly or sank under the increasingly heavy pressures involved in the process.

To meet the growing demand for a better mold steel the tool steel works of Henry Disston & Sons developed Plastalloy. This is, essentially, a very low carbon steel containing enough nickel, balanced with other alloying elements, to provide very high core strength along with high surface hardness after case-hardening. Soundness is stressed in all stages of mill practice, and a special annealing cycle has been developed to soften the steel uniformly so that it is almost as easy to hob as the softer irons.—*Nickel Steel Topics.*

METALLIZER SAVINGS

Metal Coatings Salvage Railroad Equipment

In recent years the metallizing process has found numerous new applications not only for coating metals but also for repairing machinery by building up worn parts with deposited metal. This process, described years ago in Scientific American, consists in the melting of a metallic wire as it passes through a hand gun, and squirting the molten metal in spray form against the material to be coated.

An important new application of metallizing has been worked out by a well-known middle-western railroad. That company is reclaiming many locomotive parts which would normally be scrapped, by first metallizing the worn part with stainless steel and then machining the part with Carboloy tools down to proper size. The company claims that such parts as shafts, water-pump piston rods, motor shafts, and other such equipment are giving 100 to 300 percent of their original service life after being thus reconditioned.

RUBBER SUITS

Conduct Electricity and Warm Aviators

Rubber, ordinarily an insulator against electricity, has now had this characteristic so reversed that it not only conducts electricity but does a very useful job. Researchers of the United States Rubber Company have added certain chemicals during the rubber mixing process,

with the result that a sheet of rubber can be made to act very much like an electric heating pad.

To indicate the value of this development it is first necessary to look backward a bit. At the outbreak of the present war, the French air forces were at a disadvantage because their entire planes were heated. As the war progressed, air fighters went upward from three miles to an altitude of six or more. At these great heights, the outside temperature may be 20 to 30 degrees below zero; the heated French ships would frost up on the windshields so that visibility was cut to zero. All they could do then was to turn tail and go home. The Germans, on the other hand, equipped their air crews with silk underwear suitably wired and attached to the planes' generators to keep the men warm while the rest of the planes remained cold and did not frost up.

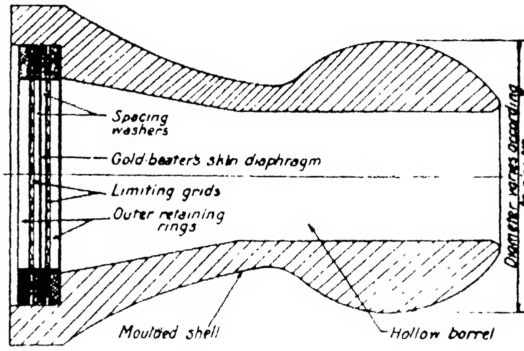
Thus it may easily be seen why the new electrically conducting rubber finds its first use—and a vastly important one—in new suits for aviators. When electrically connected to the planes' generators, the rubber conducts electricity and throws off radiant heat over its entire surface.

EAR PROTECTOR

Permits Hearing, Protects Against Bomb Blasts

Casual conversation regarding the dangers to the civilian population in London during bombing raids often comes around to the question of ear protection. Comment in the newspapers recently indicated that the British Government has issued ear protectors of several kinds to the public, and the magazine *Plastics* (London) recently described one of these, made of molded plastics.

This particular ear plug, known as the Mallock-Armstrong Ear Defender, was first invented before the World War as a result of experiences on gun-testing ranges. Present interest in it lies partly in the fact that it is now made of a plastic, but more so because of its ingenious construction. Our illustration, used through the courtesy of *Plastics*, shows the design of the plug and its grids and diaphragm; the vibrating diaphragm is of goldbeater's skin.



Cross-section of the British ear-protecting device designed to permit hearing of ordinary sounds, yet to protect against ruptured ear drums during heavy bombardment. Drawing shows how diaphragm is fitted into the molded shell

The bulbous end of the Defender is fitted into the outer canal of the ear which—if the Defender is a good fit—it completely fills, blocking all passage of air to the ear. The diaphragm, free to vibrate within the limits of the screens, faithfully passes on to the ear all sounds of normal amplitude, such as speech, music, and so forth; in the presence of loud noise, the diaphragm's movement is restricted and, in consequence, the passage of the noise is largely obstructed. Likewise, any sudden change of air-pressure such as would be caused by an explosion or series of explosions is unable to reach the ear-drum, as it causes the diaphragm to lean against the screen where any further movement is checked.

It will readily be seen that the presence of the Defender in the ear obviates all likelihood of a ruptured drum; even the temporary deafness, which usually follows exposure to excessive noise, is completely eliminated and the hearing remains fully sensitive for the reception of small sounds.

WET-SURFACE PAINT

A new paint which may be applied directly over a condensing surface covered with water, and which will hold as tightly as though the surface were bone dry, has just been announced. Called Underwater Paint, this coating works and brushes easily and will seal and paint in one coat such highly porous surfaces as wall boards, plaster boards, and gyp-

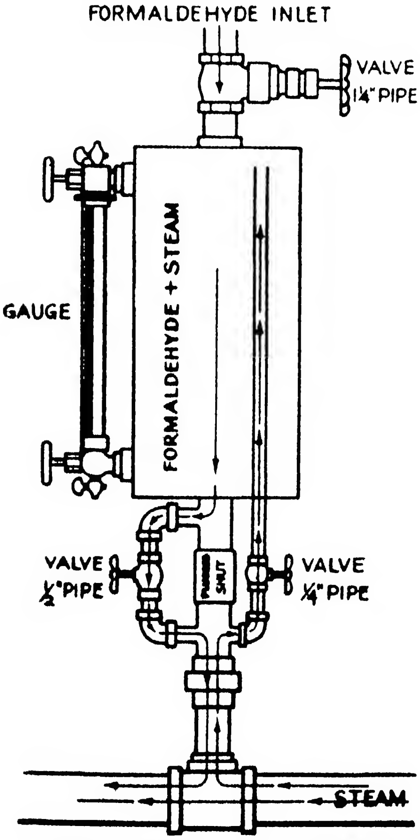
sum blocks. It is made in white or in tints. It is useful for painting below the ground surface on basement brick, concrete, and cinder block walls, as well as in tunnels, swimming pools, and the like.

GREENHOUSE SOIL

Sterilized by Formaldehyde and Steam Mixture

A NEW sterilization method for the control of wilt and club root in greenhouse soil, now being used by four growers near Toledo, Ohio, is described as unusually effective. The process, as applied by the Slayton Greenhouse Company, one of the four, is based on the admixture of formaldehyde with steam, and passage of the hot mixture up through the bed.

The cost is reported to be materially lower than the conventional treatment with steam alone, and requires only one third the time. In addition, the Slayton Company



Mixing device for sterilizing soil with steam, formaldehyde

describes their house as the "cleanest it has ever been" with respect to wilt and club root. Only one treatment a year, between spring and fall crops, is normally required.

W. L. Slayton, proprietor of the company, utilizes piping tile formerly employed for steam treatment alone. Formaldehyde and steam are introduced below the surface of the soil, thus combining the advantages of heat, steam, moisture, and hot formaldehyde. Uniform dissipation of the formaldehyde through the bed is reported. Changing of the soil is unnecessary.

The layout of the apparatus for adding formaldehyde is shown in our drawing.—*Agricultural News Letter* (Du Pont).

SCIENTIFIC PERIODICALS

Thousands are Regularly Published

IN 1934 a "World List of Scientific Periodicals" was published in England, containing the names of more than 36,000 scientific and technical journals, a number which sometimes staggers those who thought there were half a dozen, or perhaps half a hundred, or even half a thousand, but not 36,000. Today there are fewer, hard times and war costs having somewhat reduced the list. *Nature* (London) states that there now are 15,000 "containing useful articles." This leads to the hint that not all of the 36,000 were as useful as some of them. Just where to draw the line has always been a matter of opinion, and perhaps some of the journals were not outstandingly important, though each journal is in a position to contribute its share to science.

No single scientist possibly can read all these journals, nor can many keep track of all the periodical literature, even within their own branch of science. Therefore, some branches publish special journals which abstract major articles within those branches. *Biological Abstracts,* for example, does this but, even then, the reading consumes more time than a busy biologist always can find. The cry now therefore occasionally heard, for journals that abstract the journals that abstract the journals, is not altogether meant to be humorous.

In case any reader is suddenly inspired to write and ask this magazine kindly to write out and send him the list of 36,000 journals—and experience shows that when a list of any kind is mentioned some inevitably will do this—be it said that the list is a large, fat 780-page printed volume, which in the copied form of a letter would be rather fatter still!

CAMERA ANGLES

Conducted by JACOB DESCHIN, A.R.P.S.

Shoot Color Outdoors In Any Light

IT USED to be said: never attempt a color subject unless the lighting is flat—that is, behind the camera. And then we'd all go ahead and do otherwise. The results were sometimes surprising; we found that, if the exposure was proper for the shadows, just as we would want with black-and-white film, the "pictures came out"—and with beautiful faithfulness, too! The rule still goes that, for the most brilliant results, direct sunlight, preferably softened and diffused by light clouds, is the light to use. But this does not mean that *unless* there is flat illumination, you might as well fold up the color camera and shoot, if you must, only black-and-white film.

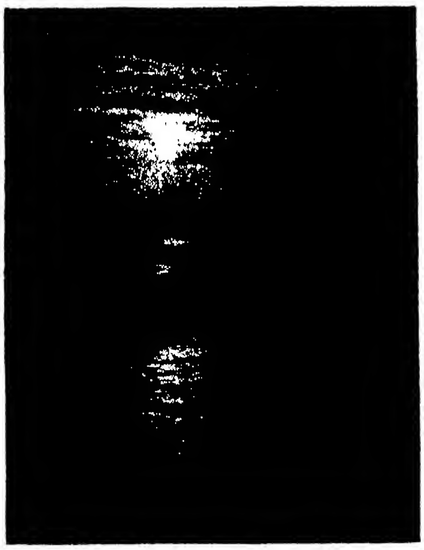


Figure 1

What most amateur workers apparently fail to realize is that although color film, such as Kodachrome, does have a rather short exposure latitude, there is considerable latitude in the choice of lightings. Certainly, we have proved this for ourselves beyond any question during a recent vacation when we had occasion to expose Kodachrome in lighting varying from that available at sunrise to the darkish illumination of the dusk. Where, by employing an exposure meter of the photoelectric type, we gave an exposure within the range of the film, the results proved satisfactory and when projected on a screen before a group of guests elicited the comment that the scene looked real. And you can't ask for more than that!

Those who say that color is limited to box-camera technique when it comes to lighting must remember that even when shooting black-and-white,

Figure 2

shadow areas are darker and less brilliant than the high-lighted areas. For example, in shooting a sunrise, is it not a truthful portrayal of the scene to show the landscape or seascape as darkish, with much silhouetting of boatmasts, buildings, and so on? Why, then, argue against color on this account because the same thing happens? Perhaps this comparison seems a bit far-fetched because most persons do not object to underexposed landscapes in color shots of sunrises, but it will serve to make the point.

Recently, at the annual meeting and dinner of the Oval Table Society in New York City we had the pleasure of witnessing a remarkable proof, in 16mm Kodachrome movies, of the extreme lighting latitude permitted the color worker, John V. Hansen, of Washington, D. C., long noted for his excellent work in this field, showed movies of the beginning, progress, and culmination of a rainstorm over the Grand Canyon. If any of those present ever doubted that the pre-

Figure 3

Grand Prize Winners

From the 36 prize and honorable mention winners in Scientific American's Fifth Annual Photography Contest were selected those three prints which, in the opinion of the judges, were the outstanding ones of the entire contest. Those photographers who submitted these Grand Prize winning pictures were awarded Weston exposure meters in addition to the regular prizes which they won.

1st Grand Prize

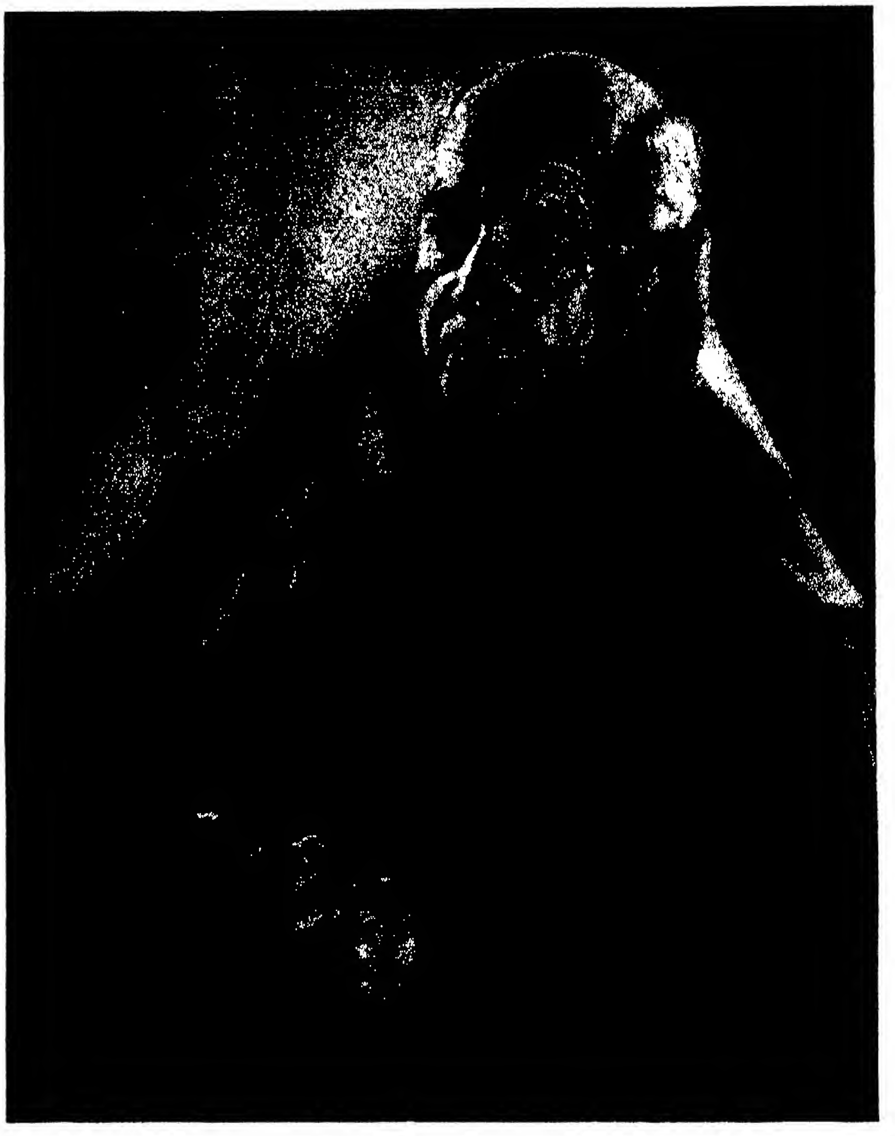
"Pax Vobiscum." **Submitted by Edwin McQuoid, Los Angeles, California. Taken with a Korona view camera, on Eastman Super XX film. Enlarged on Eastman G2 Projection paper with a Laborant enlarger.**

2nd Grand Prize

"Before They Came." **Submitted by D. P. Rudd, Los Angeles, California. Taken with a Voigtlander camera on Eastman film pack. Enlarged on Eastman G2 Projection paper with a homemade enlarger.**

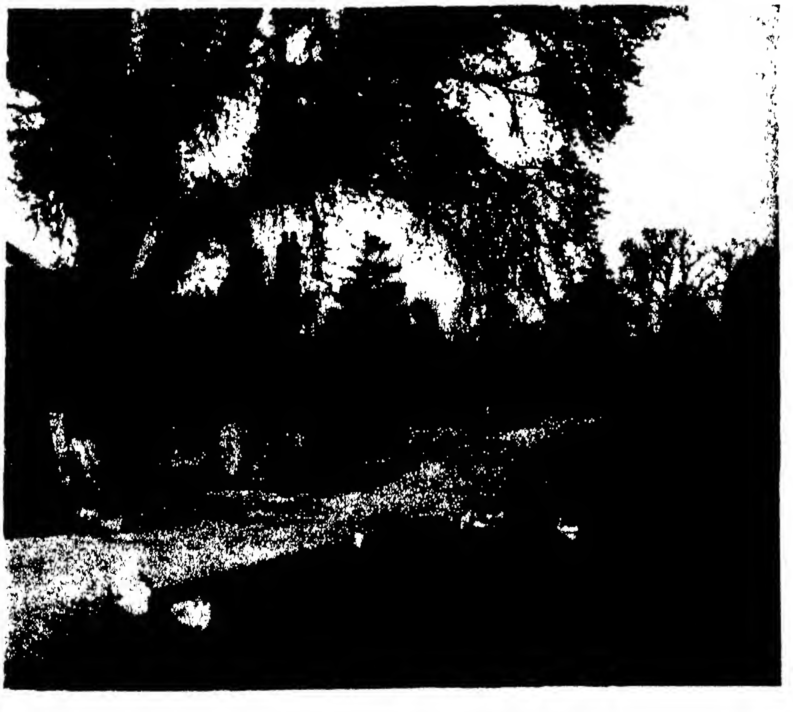
3rd Grand Prize

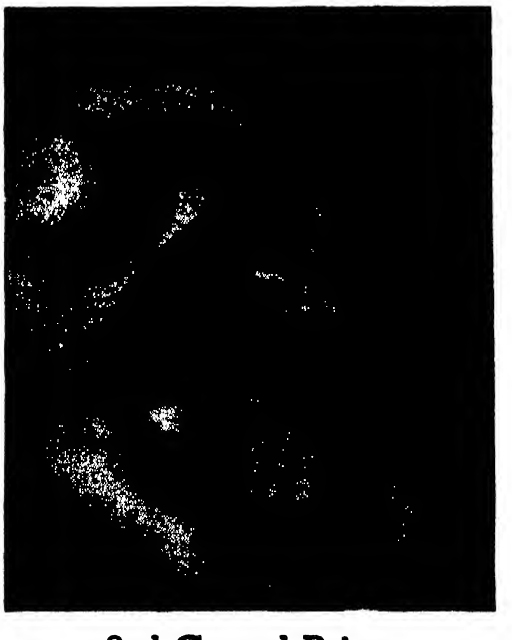
"South of the Rio Grande." **Submitted by H. C. Von Wald, Glendale, California. Taken with a view camera on Eastman Portrait Pan film. Enlarged on Kadabrom with an Elwood enlarger.**



1st Grand Prize

2nd Grand Prize





3rd Grand Prize

Figure 4

dominant coloring of the mountains during certain lightings was rather purplish, here they had the evidence before their very eyes that it was really so. But the point we want to make is that the light varied from very bright to quite dark with never a false color that the eye could object to.

The answer lies, as we have said, in proper exposure. By suitable altering of exposure during the variations in the lighting, Mr. Hansen was able to tell his story in technically perfect knowledge that, because of his mastery of the exposure problem as well as the intrinsic beauty of the subject, also had a tremendous appeal to his audience's emotional responsiveness.

Returning to our own humbler efforts with still cameras employing 35mm and Bantam-size Kodachrome frames, the reproductions shown here are black-and-white prints of subjects we also shot in Kodachrome. Figures 1 and 2 are inevitable, of course, for the color worker on vacation. Sunrises and sunsets offer an irresistible attraction because black-and-white, no matter how well executed, can never equal the color shot of the same subject. But this is so patent that no argument is really necessary. Figure 1 in color shows the golden light of the sun in a way that is not only convincing but re-enacts the whole scene as the photographer saw it, while Figure 2 had a reddish cast in the sky with good rendering of the water. The boats are seen as black on the screen, just as the same boats, in black-and-white, are silhouetted in the reproduction.

Figure 3 is another example of the sort of subject, with average lighting, that works equally well for both black-and-white and color, and the same goes for Figure 4. The shadow areas have less color brilliance than the high-lighted areas, but the results in both mediums are highly satisfactory, because true.

The thought we would like to leave with those of our readers who are hesitant about shooting color when the lighting conditions are not at their best, is that, whatever the lighting may happen to be, if the subject looks good and the exposure is correct for Kodachrome, the result will please. Exposure, not slavish adherence to flat-lighting, is the keynote to good results.

The Contest is Over

OUTSTANDING examples of amateur photography characterized the Fifth Annual Scientific American Contest. From the many hundreds of prints selected, the judges were hard put to select the 36 prize and honorable mention winners; the selection of the three Grand Prize winners was even more of a task. Those who won through to the final judging and were awarded prizes were up against stiff competition and have every reason to be proud of their work.

Reproductions of the three Grand Prize winners appear on another page; those who won other prizes and honorable mentions are listed below. The prizes awarded in each of the three divisions were as follows:

- 1st: $125 Longines, Coronation Model, solid gold, men's wrist watch.
- 2nd: $65 Longines, Presentation Model, solid gold, men's wrist watch.
- 3rd: Federal No. 246 photo enlarger (List Price $49.50).
- 4th: Federal No. 345 photo enlarger (List Price $42.50).
- 5th: Pierce Chronograph men's

wrist watch (List price $19.75).

6th: Berman-Meyers flash gun complete with case (List Price $15).

7th: Fink-Roselieve vaporator (List Price $12.50).

HONORABLE MENTION

1st: Fink-Roselieve "Hi-Spot" Hollywood type spotlight.

2nd: Mimosa Perkino developing tank.

3rd: Raygram Wood-Chrome tripod.

4th: Fink-Roselieve audible timer.

5th: Fink-Roselieve Satin-Chrome range finder.

FIRST DIVISION WINNERS

PRIZE	
First	Edwin McQuoid (See Grand Prize Announcement)
Second	H. C. Von Wald (See Grand Prize Announcement)
Third	Shigeto Mazawa, Chicago, Illinois
Fourth	Elmer L. Onstott, St. Louis, Missouri
Fifth	J. P. Whiskeman, Jr., Richmond, Virginia
Sixth	Paul J. Cohen, Brooklyn, New York
Seventh	William Eisenberg, Brooklyn, New York

HONORABLE MENTION

First	Matthew R. Barcellona, Buffalo, New York
Second	Henry M. Blatner, Albany, New York
Third	Henry Inn, Honolulu, T. H.
Fourth	Rowena Fruth, Connersville, Indiana
Fifth	Mrs. Eugene Landess, Fayetteville, Tennessee

SECOND DIVISION WINNERS

PRIZE	
First	D. P. Rudd (See Grand Prize Announcement)
Second	H. Valdemar Lidell, Portland, Oregon
Third	John R. Hogan, Philadelphia, Pennsylvania
Fourth	Thomas O. Sheckell, East Orange, New Jersey
Fifth	Douglas Rudd, Los Angeles, California
Sixth	Albert Crownfield, Jr., Waltham, Massachusetts
Seventh	Waldo Ellis, Kansas City, Missouri

HONORABLE MENTION

First	Richard M. Stevens, Chicago, Illinois
Second	Marion Aldrich, Chicago, Illinois
Third	B. W. Leroy, Portland, Oregon
Fourth	Alvin W. Prasse, St. Louis, Missouri
Fifth	M. Richter, New York City, New York

THIRD DIVISION WINNERS

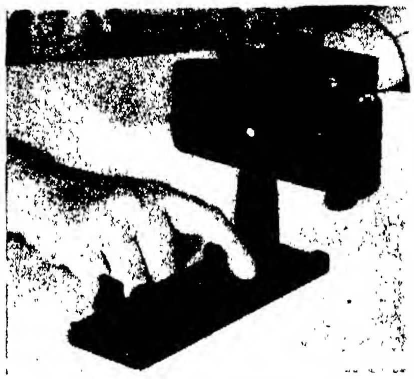
PRIZE	
First	Jerry J. Kroutil, Woodside, Long Island, N. Y.
Second	Joseph G. Danley, Trenton, New Jersey
Third	Karl E. Ahlstrom, Boston, Massachusetts
Fourth	Nathaniel Field, Brooklyn, New York
Fifth	George L. Bewley, Philadelphia, Pennsylvania
Sixth	Charles Frank Dreyer, Mt. Vernon, New York
Seventh	Frank J. Roos, Jr., Columbus, Ohio

HONORABLE MENTION

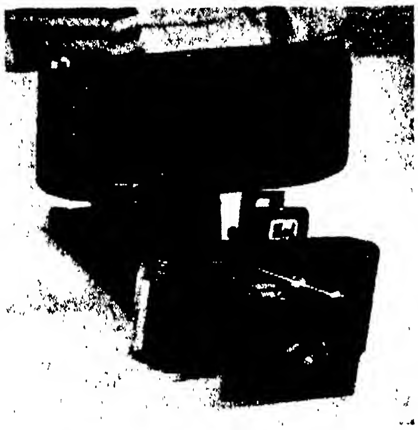
First	R. E. Hine, Milwaukee, Wisconsin
Second	Thomas E. Benner, Urbana, Illinois
Third	Tom Brady, San Jose, California
Fourth	Yuichi Idaka, Chicago, Illinois
Fifth	Russell E. Smith, Tarentum, Pennsylvania

Sliding Bed

SMALL cameras of the miniature type, factory equipped with fixed-focus lens, normally enable the operator to take pictures as close as five feet from the object. For still life and other purposes, it is possible to slip a supplementary lens over the camera lens, the combination enabling pictures to be taken at much shorter distances, up to about 25 inches or



The sliding bed set-up



Camera and sliding bed

less, depending on the type of camera. These exact distances are stated for the supplementary lens intended for use with any particular camera and must be measured with a rule or tape, from the lens to the object.

When a camera so equipped is supported on a tripod in the usual manner, the problem of setting this exact distance sometimes proves awkward. The job can be made much easier by building a sliding base upon which the camera can be moved back and forth through a distance of a few inches.

Suppose the required exact distance is 18 inches. The tripod holding a sliding base and camera can be placed anywhere from one to two feet from the object; then, using the sliding base, the camera can be slid forward or backward the required few inches. A sliding camera bed of this description can be easily constructed from few materials; the photographs show one.

A metal shelf bracket from the 5 and 10 is affixed to a narrow piece of sheet metal about eight inches long. This strip slides in a second, heavier piece of metal of the same length. This heavy section is also drilled and tapped for a ¼ x 20 machine screw which is the same size and thread as the one in the top of your tripod.

The narrow piece of metal holding one side of the shelf bracket, and sliding back and forth in this base, is also fitted with a clamping screw so that it can be locked tight at any point.

The vertical section of the shelf bracket is fitted with a small snug-fitting plywood box to hold the camera. The box is fitted with two ¼ x 20 screws. One of these fits through the center of the back of the box, through the shelf bracket, and is made fast with a wing nut. This allows the camera to be used vertically or horizontally, by simply loosening the thumb nut and swinging the camera around. The second screw is short, and fits through the bottom of the box and up into the camera tripod bushing, thus preventing the camera from falling out of the wooden holders.—*Herbert E. Hayden.*

• • •

WHAT'S NEW

In Photographic Equipment

KODAK SENIOR SYNCHRONIZER, SPEEDGUN MODEL E ($16.50, complete with mounting bracket, reflector, cable release, but without batteries): For use with Kodaks and other cameras having setting-type front shutters and standard cable release sockets. Features: Two sockets, one vertical for Nos. 11A, 16A and 21 Photoflash lamps; other centered in back of reflector for No. 5 (midget-type) lamps; both sockets with lamp-ejector; pol-

ished, parabolic reflector adjustable for vertical centering; magnetic tripper, adjusted to critical accuracy with aid of photronic testing machine, rechecked after complete assembly, then sealed; simple synchronization to any shutter without exposure tests, up to and including 1/400 of a second; metal-covered cable release; prompt cocking by pulling down plunger at bottom of tripper unit; green signal on side of plunger cylinder, indicating if synchronizer is cocked; safety catch to prevent unintentional release; all-metal construction, including buffed chromium battery case; uses two 1.5-volt C cells (not supplied); compact overall design arranged for rapid assembly and demounting. Regular re-

flector distributes even spread of light over 60-degree angle. Also available, 5-inch aplanatic reflector.

YANKEE ADJUSTABLE FILM TANK ($1.85): Takes roll-film 35mm to No. 116, inclusive. Made entirely of non-corrosive Bakelite. Wide-mouth funnel in lid permits easy pouring; wide slot for emptying without spilling or dripping. Deep pitch of spiral groove in film spool makes for easy loading and unloading without scratching. Bakelite rod in slot for agitation; thermometer may be inserted when agitator rod is removed.

REPEATER KODASCOPE MODEL G ($150, lens extra): For automatic repeat projection of 16mm films with time interval between each showing. Intended for use in shop windows, exhibition booths, and so on. Projects any 16mm film up to 400 feet, or any desired part of film, then turns off lamp and rewinds self; then automatically opens another projection cycle. No cutting or loop-splicing of film required. Aside from repeat mechanism, Repeater Kodascope Model G is identical with regular Kodascope G. Available, six lenses in variable focal lengths and three lamps of various wattage, providing choice of 18 lens-lamp combinations. Carrying case, which may be used as projection stand, $13.50.

KODAK DAY-LOAD TANK FOR 35mm FILM ($6.95): Includes bottle of DK-20 Kodak Fine-Grain Developer to make 16 ounces solution, capacity of tank. Tank permits transfer of exposed film from standard 35mm miniature camera magazine to tank reel in full light. Affords protection from

dust, accidental kinking, fingerprints. Two chambers provided—small side chamber for magazine and developing chamber. Tank reel permanently attached to lid, permitting operation of both as unit. Empty film magazine can be removed after reel is loaded. Whole operation takes only a few moments.

EDWAL QUICK-FIX ($1 quart): Acid hardening fixer said to clear films in one minute or less and completely fix and harden negative in three minutes. Contains new fixing agent; sodium thiosulfate (ordinary hypo) not used in its manufacture. One quart makes gallon of working solution. Intended for negatives only. For fixing prints, or for negatives not requiring high-speed fixing, dilute quart to make two gallons of standard solution.

KODAK DIRECT POSITIVE PANCHROMATIC FILM (Bantam, 8-exposures, $.35 roll; 36-exp. 35mm, $1.25 roll; developing outfit, $3): Used in camera as usual but yields black-and-white positive film transparencies for mounting as 2 by 2-inch slides for screen projection in regular miniature Kodachrome projectors. High-speed, extremely fine grain, fine tone quality, suited for all-around photography, indoors or out, by daylight or artificial light. Suggested speed ratings: Daylight, 50 Weston; tungsten, 40 Weston. Panchromatic sensitization Type C, with same filter factors as for other films in this group. Although reversal film, re-exposure to light not required during processing. Suitable processing chemicals supplied in Kodak Direct Positive Film Developing Outfit in quantities to make one quart each of special solutions. Developing in regular tank.

FILMO VISUAL REVIEW: New 8-page magazine devoted to visual education, published by Bell and Howell. First issue leads off with article by Professor W. Gayle Starnes, of the University of Kentucky, entitled, "Looking Into the Future," in which rôle of motion pictures in education is discussed and analyzed. Another article covers use of film by athletic coaches; brief reviews cover important classroom films. Includes three departments, "Notes from the Screening Room," discussing such subjects as importance of color versus sound, in the educational film; "For Operators Only," in which various ways of using modern motion picture projectors are explained; and "New Visual Education Tools," illustrating and explaining new items. All schools and visual educators previously receiving "Filmo Topics," in which visual education page appeared, have been placed instead on the mailing list for "Filmo Visual Review." Scientific American will be glad to forward to Bell and Howell the names of new subscribers.

ISO-COLOR PROCESS ($5.95): Consists of seven vials, each containing necessary chemical, packed dry. Kit contains sufficient amount of each chemical to make at least twenty 8 by 10-inch color prints. Manufacturers say process makes possible simple, rapid, and inexpensive method of producing color prints from separation negatives "almost as quickly as black-and-white prints can be made."

YOUR FIREARMS and FISHING TACKLE

Conducted by A. D. RATHBONE, IV

INTEREST IN FIREARMS *is traditional with American men; fishing tackle is a requisite of one of the world's oldest occupations. Scientific development of guns and tackle, in the use of which millions yearly find sport and recreation, fathers this monthly department which welcomes correspondence from readers.*

"Let's Fight!"

To our way of thinking, The National Rifle Association has summed up the various proposals to register privately owned sporting firearms most succinctly in its new publication, "Let's Fight This 'Fifth Column' Trap."

Pointing out the highly developed technique applied to subversive propaganda by Communist, Fascist, and Nazi machines in Europe and the Americas, the N.R.A. states that "it is well known that exactly this technique has been used for several years in the United States and that many honest Americans, falling victims to their smooth propaganda, have served as perfect 'fronts' for foreign propaganda agents in all walks of American social, business, and political life.

"Now," continues the N.R.A., "it appears that the familiar technique is being applied to strike at the roots of our preparedness program. In every part of America public officials are being propagandized with the idea that in order to save America from the 'Fifth Column,' the possession of firearms by citizens must be strictly controlled by the political authorities. All the old, familiar sugar-coating appears in the current propaganda; 'no inconvenience,' 'no registration fee,' 'no danger to those who have a good reason to possess a gun,' 'important to the national defense.' Sweet nothings! When a gun is registered with the political authorities of a nation, state, or community, the ultimate fate of that gun lies in the hands of those political authorities—or their successors! The question of what constitutes a 'good reason' to possess the gun lies in the hands of the political authorities—therefore the power to confiscate the gun or to jail the citizen gun-owner lies in the hands of the political authorities. Concurrently, the power to legally arm their own strong-arm squads lies with those same political authorities! Does such a condition promise defense for the American form of Government and homes against the 'Fifth Column'?"

To that question we hasten to go on record with an emphatic "NO!"

We heartily recommend that you read the entire story in "Let's Fight This 'Fifth Column' Trap," and we'll gladly send you a free copy. If you subscribe to the tenets of the American pioneers who made this country what it is, who stood unalterably for the inalienable "right to keep and bear arms," and said so in our Constitution; if you would keep these things inviolate, we maintain the answer is, "ORGANIZE!" The leading national organization of gun-owners in this country, the one that has upheld their best interests for the past 69 years, is The National Rifle Association of America. Nuf sed!

Gee! Haw!—Back up!

Every trolling fisherman who has snagged his best line has experienced that momentary lump-in-the-throat feeling, especially when he discovers that it *is* a snag, and not a fish, that has retarded piscatorial progress. To Evinrude Motors, therefore, goes a vote of thanks from the trolling fraternity for introduction of a full reverse feature in 1941 models of ever-popular Evinrude "Sportsman" and "Sportwin." Former is a favorite light motor for family and fishing service, weighs only 26 pounds, gives speeds up to 7½ miles per hour, is equipped with rubber protection clutch, weedless propeller, develops 2.0 N.O.A. Certified Brake H.P. at 3500 R.P.M. under Evinrude's dynamometer test (September 1940).

"Sportwin," a powerful twin for rowboats and medium-size family boats, has same rubber-mounted propeller protection clutch, extra large fuel tank with 2½-hour cruising range, develops 3.3 N.O.A. Certified Brake H.P. at 3500 R.P.M. Both are popular priced power plants, incorporate full reverse feature in 1941 models, and may be equipped with Evinrude's Simplex Starter for small additional charge.

Streamlined housing for 1941

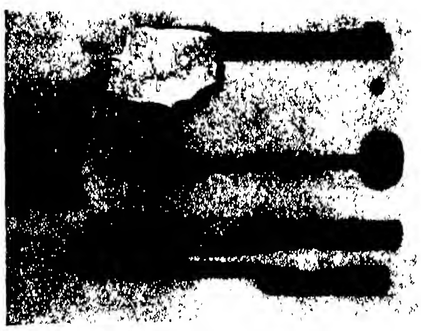
Use of outboard motors with full reverse feature will enable thousands of Waltonians to minimize wear and tear on lines, rods, tempers, nervous systems. Snagged hooks may be quickly released, often without stopping the motor, and by simply turning the motor the boat can be freely steered, or instantly put on new course. An automatic lock prevents the motor's tilting while in reverse position. Lengthened, tilting, steering handle assures comfortable tiller work at all times.

Evinrude also presents new, ultra-streamlined gear housing, free of irregular contours. Due to retention of automatic exhaust relief, unrestricted exhaust passages, and other tested and proved features, operation of new motors is as powerful, starting is as easy as before, while maneuverability has increased a hundred-fold. All Evinrude motors, including four exclusive "Fours," with complete specifications, are illustrated, described in 16-page 1941 catalog, regally done in Kodachrome. Want one?

Muzzle Loader

TELL some men, "It can't be done!" and they'll promptly accept the challenge to prove that you're wrong. Such a man is Fletcher D. Courtney, amateur gunsmith and toolmaker in the Canton, Ohio, plant of The Timken Roller Bearing Company. He spent 156 lunch and after-work hours in constructing a .423 caliber center-fire, muzzle-loading pistol just because a friend said it would be impossible to design such a gun.

Outlines of the pistol resemble the Colt Frontier model, but it is bigger,



Courtney's muzzle loader

has a larger grip, and, of course, is a single shot. Frame was machined from one solid rectangular piece of Timken TW water hardening steel. Barrel was sawed from a Swiss .41 rifle, enlarged to .423 caliber, and the original lead of one turn in 33 inches was retained. Outside of barrel is tapered 3/8 inches per foot, threaded to fit the frame of the gun. Breech plug and nipple were threaded into end of the barrel. Gun is perfectly balanced and weighs 44 ounces.

Collar and sight ramp were made of one piece of steel which was bored, machined, and press-fitted on the end of the barrel. Rear sight was milled out of the frame. Hammer and trigger were assembled without screws and were fitted over special studs that were screwed into the side of the frame without projecting through the opposite side. Because of this unique characteristic, the action is easily assembled and disassembled.

The gun uses a charge of (triple) fff-g, fine-grained, black powder. To

Top and side, showing action

prepare for firing, powder is measured, dropped into barrel of gun, a linen patch is placed over muzzle of barrel, and a lead ball laid on the linen patch. Loading plunger is then used to force ball and patch solidly into base of the barrel, after which percussion cap is placed on nipple.

Although muzzle-loading feature does slow up target practice, it has its advantage in that $1.00 will buy enough powder, caps, lead balls, linen patches to shoot from 250 to 300 rounds. As to accuracy, Courtney scored a 49 x 50 on an N.R.A. official 25-yard pistol target, proving that he not only can make pistols, but also that he can shoot them.

Science Aids Anglers

WHEN you meet a fellow angler in your trout stream next spring and ask him what kind of terminal tackle he used to land that big rainbow, don't be surprised if he says, "I was using a March Brown, tied to a 9½-foot vinylidene chloride." And don't worry about him; he's just taking the long way around to tell you about "Vec," Weber Lifelike Fly Company's new leader material that so rapidly found favor last year.

Vinylidene chloride isn't actually the name of the substance (we had to have our little fun!), but it is the base of a group of new thermoplastic resins, known by the trade name "Saran," from a formula by Dow Chemical Company. Outstanding properties of Saran are extreme tensile strength, high abrasion resistance, toughness, great water and chemical resistance, non-flammability, colorability. Weber Lifelike Fly Company saw possibilities, translated them into leaders and snells under their own trade name of "Vec."

Vec's popularity has been due to its unusual adaptability to average fishing conditions. For bait fishing, for trolling, and for snelled hooks it is

practically ideal, for it never frays or deteriorates, is always pliable, needs no soaking. Correctly tied, Vec holds fighting fish securely, being actually much stronger on a wet test than foreign synthetics of similar diameters. Vec owes its superiorities to quality and uniformity in manufacturing methods under rigid laboratory control, and is entirely a product of the chemist's test tube, manufactured by Weber from the formula by Dow Chemical Company.

Introduced by Weber a year ago, Vec is now standardized in a wide range of sizes in coils and standard leaders down to .010 of an inch in diameter. In sizes below that, Weber Straintest Spanish drawn gut leaders are supplied in all standard sizes, level and tapered.

The 10th edition of the "Weber Moviegram Method of Fly Casting Instructions," pronounced clearest, most successful system of self-instruction for fly fishermen, is off the press. As a graduate of this system, we re-read it annually to brush up on technique. Like a copy?

Keep 'Em Clean!

Have you ever been ashamed of a dirty gun? Have you ever come home from a hunt, dog tired, and said, "Oh, I'll clean it tomorrow?" And "tomorrow" you were so absorbed getting back into the harness of business that the gun went uncleaned. Then, without warning, a friend dropped in, the subject of guns quite naturally came up, followed by the customary inspection of the gun cabinet or rack, and—one gun was dirty! Was your face red?

"Ordinarily," says Frank C. Hoppe, manufacturer of some of our well known gun cleansing agents, "the proper time to clean the bore of a firearm is after each day's use. Delay invites neglect and neglect leads to a damaged gun. Make it a habit *always* to clean the bore the same day after shooting." To that we can only add, "Amen!" Not for one instant do we hold with the school of thought that it isn't necessary to clean guns after use. Frankly, we're a crank on clean guns and if you can catch us with a fouled bore, you'll have to be on our back "stoop" when first we get home from shooting.

Don't get the idea your gun editor thinks he is a paragon of firearms cleanliness; nine out of every ten shooters probably clean their guns promptly every time they use them. At least, they hope they have cleaned them after they have gone through the cleaning motions. Unfortunately, much of this labor is frequently lost due to "misguided confidence" or "wishful thinking." For that reason, and because at this time of year, when hunting seasons are over, many unclean guns go into cases and containers to remain there for months, we'd like to send you Hoppe's 16-page helpful and interesting booklet, a guide to gun cleaning and gun protection by one who shoots and knows guns.

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POT SHOTS

At Things News

The "Reel-Fold" line dryer clamps anywhere, folds into compact 1½ by 10½-inch unit, weighs six ounces, is rustproof, dries two or more lines simultaneously, reverses them end-for-end, coils them to any desired circumference, is pictured, described, priced in Mershon Company's new catalog, which is yours for the asking. Want one?

Folding line dryer

Argus Spotting Scope, product of International Research Corporation, continues to meet with approval of pistol and rifle target shooters. With indoor ranges in vogue during winter months, a good spotting scope materially helps promote winning scores. Argus is 14⅝ inches long, weighs 43 ounces, has 55mm prismatic lens, 14mm eye relief, standard magnification of 20X, with optional, interchangeable eye pieces for 12.8X and 26X. At 100 yards, Argus gives field view of 11.4 feet with 20X; 16.5 feet with 12.8X; 6.3 feet with 26X.

Argus spotting scope

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with a list of available titles, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for.

AVIATION DICTIONARY AND REFERENCE GUIDE

By Harold E. Baughman

MR. BAUGHMAN has produced a book which will be a handy reference to anyone interested in aviation—an aviation dictionary which gives excellent definitions of a great number of terms. An introduction to the main government specifications of materials and parts follows. Flight maneuvers are defined and illustrated by sketches. The regulations in airworthiness work of the C. A. A. are covered in brief. There is also a directory of manufacturers, publishers, universities, and so on. Aeronautical publications are listed. Drafting and shop mechanics are covered briefly. Design standards and primary stress analysis and materials are presented but somewhat too briefly. There are some very useful tables and formulas. (598 pages, many illustrations.)—$5.10 postpaid.—*A. K.*

HANDBOOK OF MATHEMATICAL TABLES AND FORMULAS

Compiled by Richard Stevens Burington, Ph.D.

FORMULAS and theorems from elementary mathematics make up one part of this book. The other part is composed of tables including: five-place common logarithms from 1 to 10,000, seven-place common logarithms of numbers 10,000 to 12,000, trigonometric functions, decimal equivalents, constants, common logarithms of the trigonometric functions, and, in fact, practically all the tables needed by mathematicians and actuaries. (275 pages, 5½ by 8 inches.)—$1.35 postpaid.—*F. D. M.*

THE PHYSICS OF THE DIVINING ROD

By J. Cecil Maby, B.Sc., and T. Bedford Franklin, M.A.

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MARCH OF THE IRON MEN

By Roger Burlingame

THE review copy of this book lucklessly lay for two years where it had accidentally fallen behind a shelf, till a rare editorial housecleaning revealed it. Too late for review? Ordinarily yes, but as it was read it was seen to be far too excellent and deserving a book for such fate, hence it is reviewed anyway. This book tells in fascinating style and with penetrative interpretation not alone the story of American invention—for such books are quite common—but

how our very history itself has been determined by our inventiveness, from wilderness days right up to modern times. Colonial handicraft, Ben Franklin's inventions and those that defeated the English economically in America before their colonial policy became enlightened, the cotton gin, Yankee machine tools, and many others are dealt with. An inventor's interpretation of American history, which also presents the social effects of the inventions. Reviewed in the third year of its life, with sincere apology to publisher, author and book, for regretted delay. (500 pages, 6¼ by 9¼ inches, illustrated.)—$3.85 postpaid.—*A. G. I.*

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By John F. Rider

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A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

WAY back in the year 1929, S. W. Casey, 314 Twelfth St., Eau Claire, Wisconsin, built a 3" refracting telescope, and now he has built another of similar size (Figure 1). He says the first telescope was good enough to look at, but was not so good to look through. It seems he had not yet discovered the book "Amateur Telescope Making," not to mention its sequel volume "Amateur Telescope Making—Advanced," which gives even more detailed instructions for making refracting telescopes than the first-named book. More recently, using the instructions of Taylor and Haviland in the latter volume, he completed the instrument shown, using glass blanks obtained from the Bausch and Lomb Optical Co. The tube is stainless steel seamless tubing.

"I made all the castings, also machined them, and made the eyepiece," he states. "I spent about four months of spare time on the objective. The images are beautiful." Casey had previously made a reflector.

Figure 2 shows the two ends of this 3⅛" refractor.

Figure 3 is a 4" Pyrex-mirrored richest-field telescope of unusually attractive design and appearance—clean. Casey cast and machined the aluminum cell, screw-on cover, and screw-on tube bottom (identical with the cover). All optical elements are fully adjustable for collimation. The eyepiece tube has a spiral focus adjustment. The main tube is covered with leather.

Figure 1: **Casey products**

Figure 4 caps Casey's climax, a telescoptical invention called the "Flexoscope," which he says is a technicratic aplanat of focal ratio 49.98.

From another amateur telescope maker who finally chose the refracting type of telescope comes the following: "After almost a year's use of my 7½" refractor I have found its performance, for general, all-around observing, far superior to that of my former 6" and 10" reflectors." This is from the anonymous "Mr. X," of Mamaroneck, N. Y. (address on request), whose 7½" refractor was described here last July.

Making an objective lens for a refractor is a more tedious but actually less exacting job than making a mirror for a reflector. Chief deterrent is the cost of the blanks, also the need of a flat, a lathe and a spherometer; otherwise nearly every amateur might try one. (It has been suggested by some genius that, in future copies of "ATMA," pouches be inserted at the end of Haviland's chapter on objective lens design and construction, containing the flat, spherometer, and a lathe.)

Figure 2: **Front and rear**

Despite deterrents, refractor making is gradually increasing, as more and more amateurs come to realize the truth of testimonials such as the one above. This is not, however, an attempt to depreciate the reflector. Nevertheless, many an amateur harbors in the back of his mind the hope that, some day, in some way, he can make and use a fair-sized refractor.

CASSEGRAINIAN telescopes appear to have a fatal fascination for the man who has not yet made any telescope, judging from this department's mail, and the main reason evidently is their high magnification. Most aspirants seem quite willing, however, to accept the advice of those who have been there before, to tackle a Cassegrainian only after making two or three less complicated types. A very few others have to experience the actual feeling of adversity before their self-confidence is tamed. Occasionally, too, a genius turns up who evidently can do difficult things without the preparation that others require. Rummaging among old letters, one was found in which Alan R. Kirkham, no longer active in telescoptics but "tops" while his health lasted, put the matter of lightly tackling a Cassegrainian in a new way. "A Cassegrainian or a Gregorian imposes extremely severe demands on the primary mirror. For illustration, with a secondary which amplifies the image four times, a 1" eyepiece looks the same to the primary mirror as a ¼" eyepiece, while a ¼" eyepiece looks to it like a 1/16"—and just show me the hombre who can make a mirror which will take a 1/16" eyepiece and not howl.

Figure 3: **Casey's RFT**

"My experience," Kirkham continues, "is that the difficulty of mirror figuring increases with the square of the magnification, right up to the point where the telescope reaches the resolvable minimum. If those who think primarily of high magnification would read what able designers like Conrady, Hastings, and so on, have to say about the wave nature of light and the relation of the instrument to the eye, we would hear less about it. It can be shown that a range of from 5 to 40 magnifications per inch of mirror diameter *more* than covers all the useful range, and should be obtained, on ordinary Newtonians, with ½" to 1" eyepieces. Both theoretically and practically these are the best eyepieces.

"In making a telescope one should put all the fussing into figuring the objective—mirror or lens—so well that it will concentrate as much of the light as possible within the diffraction disk, resulting in a practical telescope whose star images would not *break down* at 1000 per inch magnification if such could be used. But we will *see* all there is to be seen at 20 diameters per inch; Martin even says that 10 per inch enables sharp eyes to see all that an objective can show, and that, by doubling this, all the detail the image affords is rendered easily seen."

Unfortunately, until the telescoptician has laboriously plodded through the reasons, which in turn involves doing enough general background study of optics, in books like Valasek's "Elements of Optics," Hardy and Perrin's "Principles of Optics," and Martin's "Introduction to Applied Optics,"

Figure 4: **KC Flexoscope**

all of which would be a job to nibble away at for a year or more, such arguments don't usually seem very important and the enthusiastic tyro may deceive himself with the hope, altogether false, that high magnification will dig out the image detail even if the mirror, and therefore the image, isn't very good. But it won't! An exactly parallel experiment would be trying to compensate for poverty by writing a check for $1,000,000 payable to self; all of us could write the check but . . . . Similarly, the high magnification eyepiece on a less than fine mirror will "bounce." One may safely take this not merely from the armchair optical theorists but from experienced, flea-bitten old telescope users. High magnification requires high mirror perfection and, even then, it isn't good for much.

While it is a practical certainty that all amateur telescope makers will play harps in another world, because

of saintliness in this, one amateur who turned professional and wished to make assurance doubly sure recently began taking lessons on a tangible, mundane harp in Illinois, and immediately invented a telescope accessory inspired by it.

One of the earlier amateur telescope makers was William A. Calder, then of Beaver Dam, Wisconsin, whose telescopes were described here years ago. Calder was studying to be a physicist at the time, but the hobby swerved him into astronomy. Now he is Professor of Astronomy at Knox College, Galesburg, Ill. The "harp" applied to the telescope is shown in Figure 5, but it isn't musical. Professor Calder explains it thus:

"When a series of equally spaced rods is placed over a telescope objective, the diffraction pattern which constitutes a stellar image becomes flanked with a series of images of decreasing intensity. The relative brightness of the central and auxiliary images, and their separations, may easily be computed according to

Figure 5: **Calder's grating**

well-known formulas (King, 'Celestial Photography,' page 138). This device, the objective grating, has been very useful in connection with the problem of the relative brightnesses of double stars, but its use has been photographic. Kuiper and Hertzsprung have estimated the relative brightnesses of visual binaries by placing an objective grating over the telescope and comparing the central image of the fainter component with a side image of the brighter component. It is, however, difficult to estimate the relative brightness of objects which differ by more than a few tenths of a magnitude. By means of a coarse grating, we can divert a known fraction of the light of each star into first order diffraction images and then compare the central image of the fainter star with the effectively weakened image of the brighter star. But, when one makes a grating with the opaque space having a definite, fixed ratio to the clear space, it is found in practice that double stars whose first order image of the brighter equals the central image of the fainter are rare. Nevertheless, the eye is at its best, photometrically, when it matches intensities, but it is unable to judge the amount by which light sources differ. To improve the existing inexact data on the relative brightnesses of binaries, would it not

Figure 6: **Same old pits!**

be fine if, therefore, the astronomer could use a variable grating? He then would simply set the grating so that the central image of the fainter matched the first order image of the brighter. Then he would note how the grating was set and, knowing the ratio of clear to opaque, he would have the exact difference of brightness of the stars to an accuracy limited only by the ability of the eye in equalizing intensities.

"It would be mechanically impossible, however, to make a grating whose capacity could be varied, after the manner of the Venetian blind, but the same thing can be accomplished by the simple method of changing the projection of the grating on the telescope objective. Here is where the harp came in. Seated at the harp after my first lesson, I noticed how the clear space between the strings appeared to vary with my position. I therefore hinged the grating on the end of the telescope tube.

"I believe that many amateurs would enjoy making this accessory and could do useful work with it. My first results indicate that many of the entries in double star catalogs can be improved. The grating shown in Figure 5, on my 12" reflector, is

Figure 7: **Knife-edge test**

made of aluminum rods ⅛" in diameter, with ¼" spaces between. When the grating is perpendicular to the axis of the telescope, the first order diffraction image is 1.92 magnitudes fainter than the central image; when the grating is opened out to 40° on the hinges, the magnitude interval is reduced to 1.29."

If any reader of this department listens to Amos n' Andy, on the radio, let him be advised that "de Lodge" has a chapter among amateur telescope nuts, three of whom, though widely separated, pass as Amos (Fred B. Ferson, 414 Reynoir St., Biloxi, Miss.), Mist' van Potah (Russell Porter, of Pasadena, Calif.) and Andy (your scribe, who inflicted that name on himself in a fit of sincerity). Capt. McDowell, who superintended the 200" mounting, is "de Kingfish."

Figure 8: **Solid discomfort**

Mist' van Potah found he couldn't sleep one night, so he sat up in bed with three hunks of sugar pine and a jack-knife and whittled the bed and the room full of shavings. What was left proved to be the patterns for the four- or five-inch brass statuettes shown in Figures 6, 7, and 8.

Figure 6 is an amateur telescope maker stopping work polishing to examine his mirror with a watch maker's loupe.

Figure 7 is quite complex: a TN seated on the floor, at right, making a knife-edge test on a mirror at left. Between is his polishing place on the same plank, with a little pot of rouge and a brush sticking up, all very faithfully cast in brass.

On the occasion of a visit to Amos' cabin in Mississippi, Mist' van Potah and he spent several days together, molding, casting, snagging, filing, scouring, chiseling and otherwise finishing these objets d'art. Amos still has the patterns for making more statuettes. He is the author of the chapter on molding and casting, in "ATMA," this work being a sort of side-hobby to his amateur telescope making.

Jim Barr, one of Wally Everest's satellites in Pittsfield, Mass., took the excellent photographs, and for this he is hereby inducted into de Lodge—as "Lightnin'."

LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., L.L.B., Sc.D.
New York Bar
Editor, Scientific American

Secret Use

THE secret invention or use by a person other than the patentee of a patented machine prior to the application for the patent does not invalidate the patent. This principle was involved in a suit for the infringement of a patent on a quilting machine which blew thread, or yarn, into pockets formed in fabric to impart a raised or embossed design on the fabric.

One of the defenses raised by the infringer was that the patent was invalid because a machine similar to the patented machine had been used by another person for several years prior to the filing of the application for the patent. It apparently was established by credible evidence that the prior machine was used. However, it was also established that this use was a secret use and that every attempt was made to conceal the machine from the public.

The Court ruled that in spite of the use of the machine by another person prior to the filing of the patent application, the patent was valid since the use was a secret use. Under our patent law the Court concluded that a prior use of an invention must be a public use in order to invalidate a patent.

On Ice

IN A recent suit in the Federal Courts a former employee was compelled to assign to a corporation an invention relating to ice machinery which he made while employed by the corporation.

The corporation was engaged in the business of manufacturing and promoting machinery for producing small fragments of ice. It was originally organized to exploit a machine developed by the employee. In this machine ice was formed on a flexible member and the flexible member was than flexed to cause the ice to peel or flake off the member. While working for the corporation the employee developed another machine for making small fragments of ice wherein liquids were frozen on a stationary member and the ice was removed by a chipping action.

During the period when this machine was developed there was an employment contract between the corporation and the employee wherein the employee agreed to assign to the company "all past, present, and future inventions *** in any way relating to the same field or subject matter of the patents and applications now owned by the company." After the employee developed the "chipping" machine wherein the ice was formed on a stationary member and removed by a chipping action, he left the employ of the corporation and applied for a patent on the "chipping" machine. A demand was made that the former employee assign the invention and patent application to the corporation and upon a refusal the corporation brought suit to compel an assignment.

It was contended on behalf of the corporation that under the contract of employment the former employee was compelled to assign the invention and application to the corporation.

The former employee, on the other hand, contended that the "chipping" machine did not relate to the "same field or subject matter" as the original machine which was promoted by the corporation wherein the ice was formed on a flexible member and was released in flake form by flexing the member.

The court sustained the corporation and compelled the former employee to assign the invention and patent application to the corporation. The purpose of the contract, the court pointed out, was to protect the corporation and those interested in the corporation from competition. In order to carry out the intention and purpose of the agreement the court held that the contract must be broadly construed so as to compel the assignment of the invention and patent application relating to the "chipping" machine.

Thermostat

A PATENT for a thermostatically controlled heating system in which the thermostat is provided with an electric heating element was recently held to be valid and infringed by a Federal Court.

Most modern heating systems for homes are provided with thermostat controls. Thermostatically controlled heating units were not entirely satisfactory due to "overshooting," a defect resulting from the delay or lag in heat transfer causing the temperature in a room to continue to rise for some time after the thermostat

had shut off the heating system. This resulted in rather extreme fluctuations in temperature within the space controlled by the thermostat.

To prevent this difficulty, the patentee provided, in the thermostat, an electric heater controlled thereby so that the thermostat would operate in response to the temperature of the atmosphere in the room and also the temperature of the electric heater. It was proved that the addition of the electric heater to the thermostat overcame to a great extent the overshooting usually present in thermostatically controlled heating systems.

One of the defenses raised in the suit was that each of the elements shown in the patent was old. However, the court found that the combination was new and held that the patent was valid and infringed by the system sold by the defendant. In this connection the court stated:

"To be sure thermostats were old. The bi-metal strip was old. Heaters adjacent to a bi-metal strip are present in the prior art, but nowhere do I find a combination of means to control in this way a heating system of a house."

Clarification

THE assignee of a patent who has not recorded the assignment in the Patent Office may, nevertheless, maintain a suit for patent infringement, according to a recent Federal Court decision.

The patent law makes provision for the recording of assignments in a register maintained by the Commissioner of Patents. The law also provides that an assignment of a patent shall be void as against a subsequent purchaser without notice unless it is recorded in the Patent Office within three months of the date thereof, or prior to the subsequent purchase. This provision of the law has occasioned uncertainty and misunderstanding as to the consequences resulting from the failure to record an assignment. Some decisions have held that the assignee of a patent could not maintain a suit for patent infringement unless the assignment had been recorded in accordance with the patent law.

In the case under consideration, a suit for patent infringement was brought by an assignee under an unrecorded assignment and the Federal District Court dismissed the suit because of the failure to record the assignment.

On appeal, the Circuit Court of Appeals reversed the decision of the District Court and held that the assignee of the patent had the right to maintain the suit even though the assignment was not recorded. The Court pointed out that the recording provisions of the patent law were intended for the protection of subsequent purchasers or mortgagees and as to all other persons, an unrecorded assignment was valid.

CURRENT BULLETIN BRIEFS

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BAUSCH & LOMB AND OUR NATIONAL DEFENSE is an illustrated booklet designed specifically to refute attacks on this particular company's loyalty and patriotism engendered by the indictment which charged restraint of trade in military optical instruments. The company, incidentally, is reputed to be the largest manufacturer of these instruments. Request this booklet on business stationery. *Bausch & Lomb Optical Company, Rochester, New York.—Gratis.*

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AN OUTLINE OF MODERN FLASH PHOTOGRAPHY, by Karl A. Barleben, F.R.P.S., is a 32-page booklet providing a comprehensive review of the several factors governing flash photography today. While intended as a guide for users of the Goodspeed synchronizer, the information will be found useful by others as well. *Goodspeed, Inc., 220 Fifth Ave., New York, New York.—10 cents.*

NICKEL ALLOYS IN MINING AND MILLING EQUIPMENT is a 12-page illustrated pamphlet which gives technical data of interest to the mining engineer and mine operator. *The International Nickel Company, Inc., 67 Wall Street, New York City.—Gratis.*

FACTS YOU SHOULD KNOW ABOUT BORROWING is a 16-page pamphlet written to assist those who need to borrow money and to protect them from loan sharks. It deals with such things as building and loan associations, commercial banks, credit unions, industrial loan companies, illegal lenders, pawn brokers, and so on. *National Better Business Bureau, Inc., Chrysler Building, New York, New York.—3 cents.*

BRADLEY LUXTRON PHOTO-ELECTRIC CELLS is an eight-page illustrated catalogue of photo-electric cells as supplied to manufacturers of photo-electric measurement and control devices, or to individuals. Considerable technical information is included, with detailed data covering sensitivity, color response, and so on. *Bradley Laboratories, 82 Meadow St., New Haven, Connecticut.—Gratis.*

BETTER PICTURES WITH WATSON PORTRAIT AND VIEW CAMERAS is a 40-page booklet packed with information on the use of the view camera in making pictures in various fields. Among the subjects covered are portrait lighting, still life, commercial work, wide-angle interiors, architectural work, animal and tabletop photography, and so on. Copiously illustrated with photographic reproductions and lighting diagrams. *Burke & James, Inc., 223 West Madison St., Chicago, Illinois.—50 cents.*

BULLETIN OF THE TEXAS ARCHEOLOGICAL AND PALEONTOLOGICAL SOCIETY for 1940 is an illustrated, 252-page annual containing 12 papers on archeology in Texas and nearby states. *Cyrus N. Ray, Abilene, Texas.—$3.00.*

CALCULATE BY EIGHT, NOT BY TENS; BASE EIGHT ARITHMETIC AND MONEY, By E. M. Tingley. These are the titles of two reprints from *School Science and Mathematics*, on the advantages of the octic over the decimal system of numeration. *E. M. Tingley, 221 N. Cuyler, Oak Park, Illinois.—Gratis.*

INSTRUCTIONS FOR USING CARBOLOY STANDARD TOOLS is a 12-page vest-pocket size instruction manual for users of cutting tools. Designed specifically for machine operators, it contains information on speeds and feeds for different materials, machine recommendations, use of coolants, standard tool angles, general operating hints, and so on. *Carboloy Company, Inc., 11101 E. 8 Mile Road, Detroit, Michigan.—Gratis.*

BELL & HOWELL FILMOSOUND LIBRARY is a comprehensive catalogue of educational motion pictures which are available in 16mm size, both sound and silent. *Bell & Howell Company, 1801 Larchmont Avenue, Chicago, Illinois.—25 cents.*

BLISTER RUST CONTROL IN THE MANAGEMENT OF WESTERN WHITE PINE is a 34-page mimeographed booklet that is concerned specifically with the conservation of western white pine timber stands. Success in the control of blister rust depends largely on basic knowledge and careful planning of campaigns. *Northern Rocky Mountain Forest and Range Experiment Station, Missoula, Montana.—Gratis.*

IN production of marine reduction gears, tons of steel must be handled as delicately as the mechanism of a fine watch. Our cover picture, by Westinghouse, shows one of these gears being inspected. The allowable error in the spacing of the huge gear teeth is 1/10,000 of an inch. These marine gears are used for reduction of speed between turbine and propeller. The slightest discrepancy in machining of the reduction gears will give rise to noise and vibration.

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SCIENTIFIC AMERICAN

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NINETY-SEVENTH YEAR • ORSON D. MUNN, Editor

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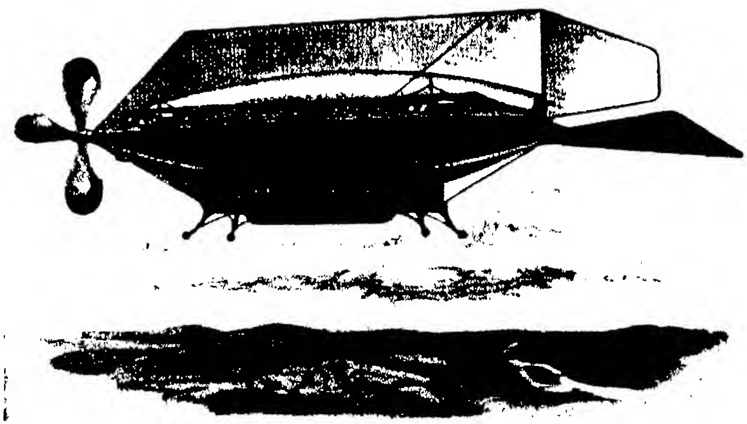
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of March, 1891)

CANAL—" In spite of the disaster that has overtaken the work at Panama, there is every reason to feel encouraged by the progress that has been made at Nicaragua. The latter route was equally open to the French engineers, and it is safe to say that, with half of the money which has been irretrievably sunk at Panama, they might by this time have had in successful operation a practical ship canal for the largest vessels through Lake Nicaragua to the Pacific Ocean."

AIR SHIP—"In the popular belief, the flying machine is next to an accomplished fact, and no very great surprise probably would be occasioned if the announcement were to be made to-morrow morning that a line of air ships had commenced to run between Chicago and New York. We are sorry, however, to be obliged to dash the hopes of a confiding public. . . . Looking at the subject from a practical point of view, our people are likely, for some time to come, to be confined in their locomotion to the actual earth's surface, and to railway cars that make only from fifty to seventy-five miles an hour. But there are various schemes for air flying, and they look fine on paper. One of these paper enterprises has been widely made known in Chicago. It is styled the Pennington air ship. Twenty millions of dollars is the modest amount of the capital. A few of the shares have been reserved for sale to a hungry public. Those who have a dangerous surplus of cash on hand can promptly reduce it by investment in this deceptive and visionary scheme." [Illustration at right. *Ed.*]



INSECT USE—"An electric apparatus supplies a strong light which attracts the insects and moths; a suction fan worked by the electric current draws them in when they approach the light, and carries them into a small mill, also worked by the electric current, where they are ground up and mixed with flour and thus converted into poultry food."

SOLUTION WANTED—"Among the scientific problems that await solution was that described by Prof. Elihu Thomson, to wit, a direct method of obtaining electricity from fuel. The present method necessitates the interposition of the steam engine, in which even under favorable conditions scarce more than ten per cent of the theoretical energy of the coal is recovered in mechanical power, this suffering diminution again at the wire end of the dynamo."

GREAT GUNS—"In France the great company known as the Forges et Chantiers de la Mediterranee, at Havre, under contract with the Japanese government, have produced some large Canet guns for the war vessels of that nation, which must be conceded to stand at the present time in the front rank. Japan may be said to beat the world in the actual power of her heavy guns. . . These guns weigh 66 tons, 12½ inches bore, 41 feet 8 inches length, maximum weight of projectile 1,034 pounds, powder charge 562.2 pounds, muzzle velocity 2,262 feet per second. . . Maximum range over 13 miles. Twenty rounds were fired in the test."

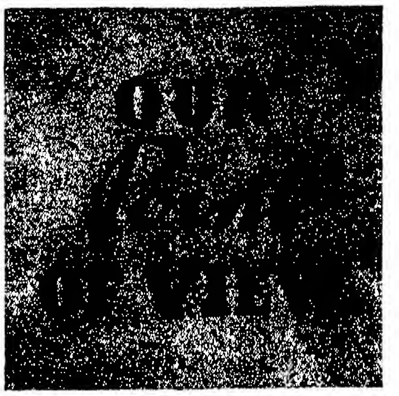
PHONOGRAPH—"One of the mechanical curiosities of the gramophone is the fact that the etched record itself is the screw which propels the diaphragm from periphery to center, for the stylus resting in the groove by gravity or slight pressure not only is vibrated, but following it and being able to move freely, is led along to the center and to the end of the etched record automatically. This places the gramophone reproducer in the realm of extreme simplicity, and beyond the necessity of repair under ordinary every-day conditions."

NEW YORK DEFENSE—"The government has recently commenced the work of locating batteries at Sandy Hook, to take the place of the old fort at that point, begun in 1858. Between that date and 1867 it is said over $1,000,000 were expended on this fort, which was to have been one of the most formidable in the world, but has become obsolete by the vast development which has taken place in modern heavy ordnance. The new batteries are designed to have twelve-inch guns and sixteen-inch mortars, with a range of from nine to twelve miles."

BOTTLES—"It is computed, in recently made statistics, that the glass bottle production of the world amounts to a daily output of a little over eleven million bottles."

TROLLEY CARS—"The overhead trolley system of electrical traction is not, so it would seem from report, by any means satisfactory; at least, in its present stage of development. Complaints come from many quarters that it is insufficient and uncertain. Much snow or rain and much leakage have come to be synonymous terms in street railway parlance.

WIRELESS FORERUNNER—"Mr. Branly has recently found that the spark of a Holtz machine or induction coil has a remarkable effect in temporarily decreasing the resistance of certain badly conducting mixtures, such as powdered or oxidized metals, or pastes formed by immersing filings of iron, copper, or other metals in a non-conducting fluid. . . The diminution of resistance of such conductors may last for as long as 24 hours, unless the substance is disturbed by vibrations, in which case the high resistance is restored."



TIME IT WAS SETTLED

THAT perennial question—which freezes quicker, hot water or cold?—is back again and will keep on coming back at us unless it is at last inescapably settled. Generally people seek an answer to this question by the method of pure reason. Recently, however, a number have made actual experiments, thus asking Nature herself. Receptacles of hot and cold water set on winter porches or in electric refrigerators certainly ought to give positive and unequivocal answers—so it would seem. Let us see whether they do.

One of our readers, Mr. Whit Wellman of Carmel, California, set trays of hot and cold water in his Frigidaire and says that the hot sample became hard ice half an hour before the cold had begun to freeze.

Another reader, Mr. Edward P. Arthur, of Altadena, California, placed in a Sierra Madre Frozen Food Cabinet at 3 to 5 degrees, Fahrenheit, identical glasses of cold city water and some of the same water that had first been boiled 15 minutes. Ice crystals formed first in the cold sample but the hot sample froze solidly first.

In the meantime, professional scientists had been trying the experiment. Professor Joseph O. Thompson, Amherst College physicist, asserted in *Science* that, of the two, the hot water will freeze first.

Dr. M. W. Lyon, pathologist at the South Bend, Indiana, Clinic, described an experiment in which the cold sample froze much sooner than the hot.

Professor G. Wakeham, University of Colorado chemist, set out identical pie tins and identical cylinders of brook water at 10, 20, 30, and 93.3 degrees, centigrade, on a porch at -14 to -17 degrees, centigrade. The cold water froze first in all except one case.

Dr. Willis R. Whitney of the General Electric Co. put a liter of water, already chilled to the freezing point, or 0 degrees, centigrade, and later on, a liter of boiling water, in an electric refrigerator (presumably G. E. made—*Adv.*) and found that, within an hour, more of the hot than the cold had frozen.

Three times the present writer set out equal volumes of cold, and just-boiled city water in tin pans and glasses on a porch. Ice formed first in all the cold samples, including one boiled 15 minutes.

Thus the tally: hot, hot, hot, cold, cold, hot, cold—what's wrong?

Nothing. Nature every time obeyed her own laws—she always does—but probably none of the seven experimenters performed quite the same experiment. Each introduced variables and the evidence is that the experiment often gives as its answer either hot or cold on the teetery basis of rather small variables. Possible factors contributing to the contradictory results include:

Professor Thompson's explanation that the hot water cools rapidly because of its rapid evaporation and loss of heat by radiation.

Professor Wakeham's suggestion that the shape and heat capacity of the receptacle are critical.

A suggestion by Robert S. Casey, Fort Madison, Iowa, that heating certain samples expels dissolved gases, decomposes bicarbonates, precipitates compounds, raising the freezing point.

Professor Thompson further points out that the hot sample, before freezing, loses an amazing percentage of volume (the writer found about 12 percent!) by evaporation, and thus gains in ratio of cooling surface to volume. He calls this the dominant role. He also says his hot samples were 100 degrees hot—boiling. (In kitchens, hot water pipes are said to freeze and burst first. Yet evaporation cannot occur here at all. Possibly this is very largely a different problem.)

All these experiments, while still far ahead of the commoner method of seeking the answer by logic and heated dispute, were more or less casual, while the question becomes more complex, ramified, and critical the more it is tested. We think, therefore, it would be well worth while for some physicist to make such extensive, thorough, and downright painstaking experiments, stopping here and there to run down every tricky ramification, as would really *surround* this question, and then publish every governing detail.—*A. G. I.*

PLASTICS DON'T DIE

SO MANY different plastics have marched out of the laboratory during the past few years that fear has been expressed in some quarters that much of the development has been in vain, that there are too many plastics for the jobs to be done. Ureas, vinyls, alkyds, aminos—these are the general classifications into which fall the wide variety of plastics now available. And within these classifications are sub-groups by the dozens. Doesn't it seem likely, then, that new plastics should replace old, render first-comers obsolete?

Were it not for the fact that so many jobs can be done by plastics—and done better than with any other material—such an assumption might prove correct. As one industrial chemist has put it, however, "no plastic has ever died." In other words, any plastic that has proved commercially practical has always found a niche which it fills to satisfaction. New plastics may come along and reduce the number or size of the niches, but so varied are the uses to which these products of chemical research may be put that there is always some one purpose for which a certain plastic is best fitted.

Such a situation provides added stimulation to research workers. The urge to create can oftimes be curbed by the knowledge that the field of applications is limited or over-filled. But when assured that industry can absorb the results of new knowledge, can find practical uses for new products, the research laboratories go forward with undiminished zeal. The plastics field is but one shining example; throughout the broad horizons of industry the laboratories are constantly adding new materials that are being turned into practical, everyday useful articles which make for richer, fuller lives for us all.—*A.P.P.*

Personalities in Science

JAMES HILLIER

Mr. Hillier (foreground) at the electron microscope with Dr. Vladimir K. Zworykin

CLOSELY interwoven with the development of the electron microscope, most effective tool ever to be placed in the hands of research scientists, is the name of young James Hillier, who was born in Brantford, Ontario, Canada, in 1915. Mr. Hillier's early interest in science may largely be attributed to his father, an engineer of scientific bent. When Jim was only 11 years of age, the elder Hillier presented him with a refracting telescope. That instrument shared the fate of most other things that fell into the youth's hands—it was taken apart. Investigation soon disclosed that the compound eyepiece could be used as a microscope.

During high-school days Jim Hillier became intensely interested in radio and photography, hobbies that he still continues to pursue as time permits. These interests, however, never excluded his studies of microscopy which now have carried him so far into the infinitely small that seeing an actual molecule seems to be a possibility just around the corner.

High-school was followed by the University of Toronto, where a B.A. in mathematics and physics was achieved in 1937 and an M.A. in physics in 1938. Post-graduate work, starting in 1937, introduced Mr. Hillier to the problem that has made him one of the outstanding figures in present-day applied electronics. Under the supervision of Dr. E. F. Burton, Director of the McLennan Laboratory of the University of Toronto, Jim embarked on a project which involved a thorough-going study of the then little-known electron microscope. With scant funds available, he and another graduate student carried the project to a successful conclusion. Most of the equipment available in the physics laboratory was pressed into service; where special parts were needed the two students made their own designs, went to the University machine shop and built their own equipment.

Dr. V. K. Zworykin and a group of the engineers at the Camden Research Laboratories of RCA had, because of close connection with the problems associated with television, been actively interested in electron microscopy. In February, 1940, Mr. Hillier joined the RCA, and here, under the direction of Dr. Zworykin, and with the collaboration of A. W. Vance and others, was able to develop the electron microscope from a complicated laboratory device into a compact, smoothly operating instrument that already is being seized upon by science and industry as an important means to new knowledge. (Details of the theory of the electron microscope will be found in the July 1940 issue of Scientific American.)

Modestly, Mr. Hillier belittles his own work, insisting that his contributions to the electron microscope have been merely concerned with developments and improvements. Nevertheless, the fact remains that, coincident with Mr. Hillier's entry into the field of electron microscopy, in 1937, things began to happen.

Today Mr. Hillier is setting out to rectify a seeming paradox in his life. Most research men establish their scientific reputations long after receiving their doctorate degrees. In Hillier's case, however, he achieved fame as plain "Mr." Hillier, and is now working toward a doctorate in physics.

Married and the father of two children, the eldest $3\frac{1}{2}$, Mr. Hillier has applied for first citizenship papers in the United States. His intellectual recreation consists of keeping abreast of world affairs; to this he adds a fondness for tennis, a love of good music, and a mild interest in fishing. One of his earliest ambitions was to become a commercial artist; other interests preventing this, he still keeps his hand in by dabbling in drawing, particularly in pastels.

SPLITTING HAIRS IN AIRCRAFT ENGINE PRODUCTION

EVEN the threads of the bolts that hold parts of an airplane engine in place must be machined to close tolerances if the finished product is to give satisfactory performance. Thus is necessitated accurate inspection equipment such as this comparator shown in operation in the Cadillac plant where Allison airplane engines are being manufactured. A greatly enlarged shadow of the thread is cast on a screen, where it must line up with a master pattern or be rejected. Here one of the four connecting-rod bolts is being checked.

97TH YEAR SCIENTIFIC AMERICAN MARCH 1941

INDIA'S WOLF-CHILDREN

Two Human Infants Reared by Wolves

ROBERT M. ZINGG, Ph.D.
Associate Professor of Anthropology,
University of Denver

• As the accompanying account of two human infants reared by wolves is extraordinary, the reader is entitled to know just how much scientific backing was required before it was accepted for publication. He may recall the unfortunate instance of last year, in which a psychologist rushed into print with poorly investigated claims concerning a South African boy nurtured by baboons; then was forced to retract his story with an admission that he had been mistaken (*Science*, Mar. 22, and June 28, 1940; also *The American Journal of Psychology*, July, 1940).

The author of the present account is a scientist in good standing; he has devoted several years, not merely to this one case but to such similar ones as could be assembled from recorded world literature (in *The American Journal of Psychology*, Cornell University, October, 1940, he discussed 31 such cases at some length, but of these the present one is the best); at least four other scientists concur formally in the genuineness of the case. These are: Prof. Ruggles Gates of the University of London, Dr. Arnold Gesell of the Yale Medical School, Dr. Francis Maxfield of the Ohio State University, and Dr. Kingsley Davis of the Pennsylvania State University. These four have contributed approving forewords to a 250-page detailed book on the present case, to be published by Prof. Zingg, author of the present article, some time in 1941. Prof. Gesell also will publish a book about it, a short, more popular account, a summary and interpretation, to be entitled "Wolf Child and Human Child."—*The Editor.* •

In 1929, when I first heard of wolf-children, my reaction, no doubt like that of everyone else, was that such stories were stuff and nonsense. However, when the study of other scientific problems brought me back to the subject of wolf-children, I found evidence of some respectability for about 30 cases on feral or wild man.

The best of these cases is that of the wolf-children of Midnapore, India. The records on this case involve 250 pages of original documents, mostly a lengthy and carefully recorded diary of the rescue of the wolf-children and their life in an orphanage run by their rescuer. In my study of these records I have been assisted by many scientists in various parts of the world. These include the distinguished American scientists who have been studying the more recent and similarly tragic cases of two girls, one in Pennsylvania and the other in Ohio, who were rescued from attics where criminal or insane guardians had kept them sequestered since babyhood. These children were rescued at almost the same age as the eldest of the wolf-children of Midnapore, and the records are surprisingly analogous in detail.

The two wolf-children of India were first seen living as wolves among wolves on October 9, 1920, by an Anglican missionary, Rev. J. A. L. Singh. He was on a mission trip among the pagan aborigines, with Anglo-Indian companions who went with him to hunt in the tiger-infested jungles of northwest India. In an isolated village Rev. Singh and his companions were told of a "man-ghost" that lived in a high, earth ant hill, characteristic of the tropics, about seven miles from the village. To this he and his companions were directed at dusk and there made a tiger-shooting platform in one of the trees. Here they awaited the promised appearance of the "man-ghost" from the ant hill.

Rev. Singh writes: "Then, all of a sudden, a grown-up wolf came out of one of the holes. This animal was followed by another of the same size and kind. The second was followed by a third, closely followed by two cubs, one after the other. Close after the cubs came the 'ghost' — a hideous-looking creature — hand, foot, and body like a human being. Close at its heels came another awful creature, exactly like the first, but smaller. Their eyes were bright and piercing, unlike human eyes. However, I at once came to the conclusion that they were human beings.

"The first 'ghost' placed its elbows on the edge of the hole, looking this side and that before jumping out, followed by the tiny 'ghost' behaving in the same manner. Both of them ran on all fours."

Rev. Singh was the only one on the platform with field glasses, so his companions could not identify these creatures as human. He continues: "My friends at once leveled their guns to shoot at the 'ghosts.' They would have killed them had they not been dissuaded by me. I held their barrels and presented the field glasses to Messrs. Rose and Richards, and told them that I was sure that these 'ghosts' were human children."

The group of witnesses again sighted the "ghosts" and wolves the next day, October 10, 1920. They tried to get the natives of that village to dig the wolves and wolf-children from their ant hill den, but the primitive villagers of this remote hinterland of India were too afraid of the "ghosts" to

do so. So, the next day, they went to a distant village where the natives knew nothing of these particular "man-ghosts." Thinking they were merely to dig wolves out of their dens, the hired diggers returned with Rev. Singh and began work.

Singh writes: "After a few strokes of the spade and shovel, one of the wolves came out hurriedly and ran for his life into the jungle. The second one appeared quickly, frightened for his life, and followed the footsteps of the former. A third appeared. It shot out like lightning on the surface of the plain and made for the diggers. It flew in again. Out it came instantly to chase the diggers—howling, racing around restlessly, scratching the ground furiously, and gnashing its teeth. It would not budge out of the place.

"I had a great mind to capture it, because I guessed from its whole bearing on the spot that it must have been the mother wolf. I was amazed to think that the mother wolf had permitted the children to live and to be nurtured by them. While I stood there inert, however, the men pierced her through with arrows and she fell dead."

With the death of the last adult wolf, the diggers now dug into the ant hill, which soon fell in because it had been undermined by the wolf den beneath. Singh says it was in the shape of a kettle, plain and smooth, as if cemented; the place was absolutely neat and clean, not a sign of a bone, much less of any droppings or any other uncleanliness, and he continues: "There had lived the whole wolf-family. The two cubs and the other two hideous beings were there in one corner, all four clutching together in a monkey-ball. It was really a task to separate them from one another. The 'ghosts' were more ferocious than the cubs, making faces, showing teeth, making for us when too much disturbed, and running back to re-form the monkey-ball."

The rescuers of these human children from their wolf companions were at a loss as to what to do until someone thought of throwing over each of them the sheet-like winter garments which the villagers wore. Thus the wolves and children were separated and caught, each wrapped in a sheet with only the head sticking out. The cubs were given to the native villagers, who sold them for their wages. Rev. Singh took the children to his headquarters at Midnapore where he and his wife have for years devotedly supported an orphanage for the waifs of that region.

The missionaries expected that a few years of association with the normal children of the orphanage would change the wolf-children from effective little animals back into human beings. The elder girl, about eight years old, was named Kamala, and the younger, aged only a year and a half, was called Amala. Rev. and Mrs. Singh decided to tell no one of their rescue from wolves lest this might later prejudice their chances of marriage, a serious thing for girls in India. Much later, however, when serious illness of the children made it necessary for a medical practitioner to know their past, the missionaries felt it necessary to divulge the facts of their rescue, and the story leaked out. It made quite a sensation locally in India, though traditions of this kind are a commonplace, as reflected, for example, in Kipling's well-known story of Mowgli. The Anglican bishop, Rev. H. Pakenham Walsh, who had taught Rev. Singh as a Seminary student, went with others to see the children and completely vouches for the authenticity of the children and for the high character of Rev. Singh. News of these wolf-children reached the world press through publication of a confidential letter to a friend in London.

Rev. Singh and his good wife were deeply disturbed by this

Photo from Rev. J. A. L. Singh

One of the wolf-children on all fours and scratching to get in

publication, not only because it blasted any hopes of marriage of the children, but also because it plagued them with visitors, newspaper writers, and numerous letters from all over the world. To science, however, it was a providential boon that the news did come out, because, for the first time among the 30-odd cases of a similar kind recorded, we have *actual witnesses* of the rescue of the children from their life as animals among animals. No scientist would dream of actually isolating a child from all human contact, even as an experiment,

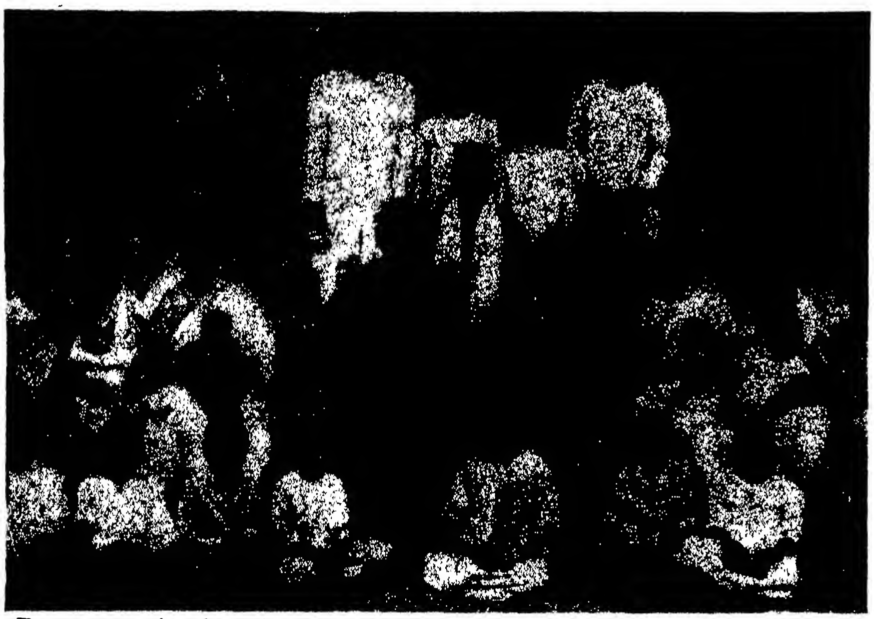


Photo from Rev. J. A. L. Singh

Rev. and Mrs. Singh, with Kamala, the elder of the two wolf-children, seated at their feet, after she had learned to walk and wear clothing

though there are stories of oriental potentates who do so to find out the effects of environment on heredity in human development.

Rev. and Mrs. Singh were to be disappointed in the degree of recovery in their little wild charges. At first they treated them like two newly-born human beings, as they essentially were in a human sense, though one was eight and the other a year and a half. They put the children in bed, where they had to be tied. Since they tore clothing off as savagely as wolf-cubs, their clothing was limited to a diaper-like breach-cloth, which had to be sewed on. Like infants, they would eat only milk. They were not offered raw meat, which they craved. This craving lasted for some time, and long afterward one of them was caught eating the entrails of a chicken, which she had located far away in the garbage by the superlative animal-like sense of smell that remained with her for many months.

Retouched photo from Rev. J. A. L. Singh

The two wolf-children soon after their rescue, sleeping wolf-puppy fashion, or curled-up in a "monkey-ball," with the younger one on top

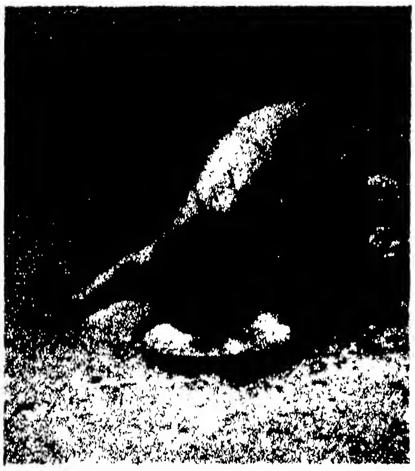


Photo by Rev J. A. L. Singh

Wolf-child lapping milk, learned from tame dogs after her rescue

When they had regained some strength from a milk diet, they were allowed out of bed. They dreaded and shunned the light, but at night roamed around restlessly on all fours, the only locomotion that they knew, moaning in imitation of the howl of a wolf, the only language that they knew. Their behavior was essentially not human. They hated, feared, and shunned human beings, as would have a wolf-cub. Yet they knew animals, liked them, and were so familiar with them that they acquired their ways. They loved dogs and from them learned immediately by imitation to lap milk out of a dish and, more extraordinary, to scratch at a door for entrance after approaching it on all fours. At first, their interest, their love, and sympathy were wholly directed to animals. Rev. Singh's diary shows what a slow and painful process it was to re-orient these pitiable little children from animal interests and sympathies to human ones. In teaching them to master the upright posture of man on two legs, not only were long and complicated exercises necessary to loosen the muscles bound into the four-legged position, but it also was necessary to get them to imitate a kitten in climbing a tree in order to loosen their leg muscles further. They would never have followed a human being as they did a cat to imitate it in climbing. They even preferred chickens to human company and would follow the chickens around the compound for hours. Neither of the children ever mastered man's upright position well enough to run, but they did learn to walk upright, though somewhat awkwardly.

The recovery of the children was sadly hindered by the death of Amala, the younger, who was learning rapidly and from whom the less plastic older wolf-child Kamala was learning. With the death of the only creature like her in the world, the surviving girl seemed to sink into a spiritless idiocy. Few could survive such loneliness but, fortunately, she began to show a glimmer of interest in her human companions, and especially in Mrs. Singh, who always fed her.

Gradually Kamala's interest in humans increased and she developed into a pathetic little, sub-normal, but clearly not idiotic, human being. She learned to speak about 50 words and occasionally to put them in short sentences. She came to recognize and to be possessive about her clothes, though they had to be red in color to interest her. Finally she came to show concern about being clad like a human being when she went out walking with the other children, or when visitors came. She developed enough human intelligence to run errands, in addition to playing with the other children.

From the entire account it becomes clear that, while the normal baby is born with the potentialities to become a human being, in the form of a more complicated nervous system than that of animals, man actually attains this only through association with his kind in the very earliest years. Deprived of this too early, or too long, or too severely, the human child never recovers complete mastery of the upright position of man, or of language, the characteristic of man, or a complete and fully developed human personality.

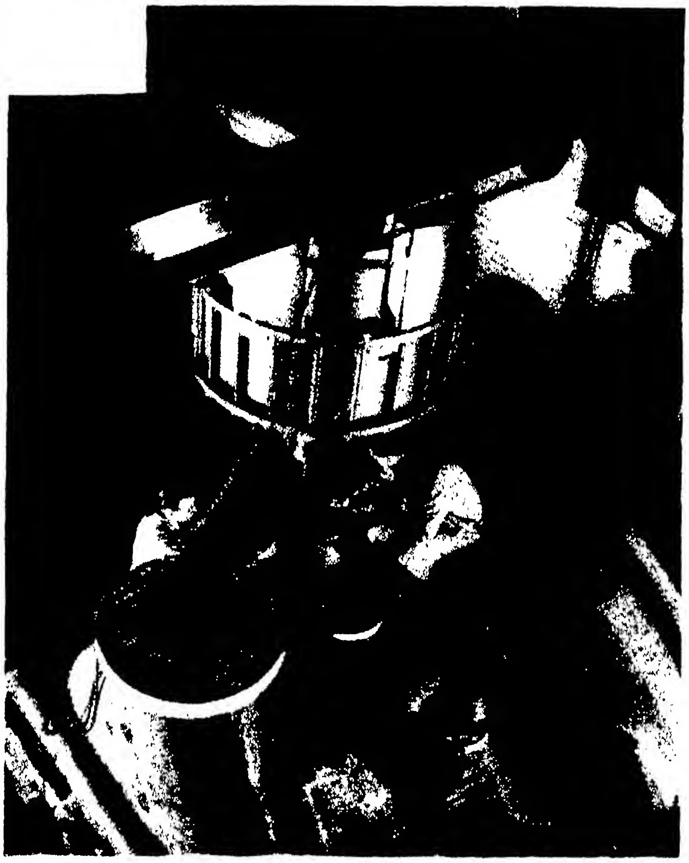
Yet the environmental factor is not supreme because by the same token even the ape, which can simulate man's upright position, cannot be taught to talk, nor does it attain a human personality. The study of the record of the wolf-children of Midnapore proves what has been indicated by other similar cases and by the rest of our knowledge—that both the environmental and hereditary factors unite in a complex interplay to develop the human being.

X-Rays Show the Way

New Equipment for Peace and War, For Use By Industry and by Medical Science

A. P. PECK

X-RAYS, born of scientific curiosity and raised by the research laboratory, are constantly under scrutiny in an effort to increase their already widespread use. A whole corner of industry is devoted to studying ways and means of producing more powerful X-ray generating equipment, better ways of applying technique, new uses for these rays that enable us to see the unseeable. From X-ray spectroscopy to the diagnosis and treatment of disease, from routine inspection of welded joints to the study of broken bones, from the industrial production line to the examination of food products ranges the applications of the rays, and the industry behind the X-ray keeps pace. Rather, it should be said, the industry keeps a step ahead, showing the way and providing the tools for others to take up and apply.



Business end of the 1,000,000 volt industrial X-ray unit being lowered into a huge steel casting to be studied

Latest of the giants in this field is the million-volt unit produced by General Electric for industrial uses. Designed for rapid inspection of huge machine parts—steel turbine castings, for example—this unit will more than pay for itself by the savings that it will effect by the detection of flaws before the machinery goes into actual service.

X-ray inspection of machine parts has, of course, been an established industrial practice for many years. Through the findings of the X-ray, it is possible to repair flaws, or to reject the part, before the defect shows up by failure of the machine and possibly causes damage far in excess of its seeming importance. With the relatively small, low-powered equipment heretofore used, the inspection process may be lengthy, out of proportion to the rest of the production schedule, but with the new million-volt unit it is possible to do in minutes what took hours with the best equipment formerly available. For example, the 400,000-volt unit which is replaced by the new installation required a one hour exposure to take an X-ray picture through four inches of steel three feet away from the ray source. With the million-volt equipment, the same work is done in less than two minutes. The former three and a half hour exposure for five inches of steel is reduced to five minutes. The exposure time is increased two and a half times for every added inch of steel to be pictured with the new unit.

Without going into the theory of X-rays, it is rather obvious that the penetrating power of the rays is dependent on several factors, primary of which is the operating voltage of the generating tube. Of importance also are the material to be penetrated and its distance from the ray source. Lead is quite opaque to the rays, air the most transparent. Well known, also, are the destructive powers of X-rays to life. They can, when uncontrolled or improperly applied, cause irreparable damage to the human body; at the same time it must be remembered that, intelligently used, they can be equally powerful in their beneficial results.

Thus every possible precaution is taken in the design of X-ray equipment to guard against trouble, and to afford every facility for ease of operation. In the case of the new million-volt unit at Schenectady, for example, a special building has been provided. The walls of the structure consist of 14 inches of solid concrete, plus 12 inches of brick on the interior, giving the protective effect of four inches of lead. The foundations of the building extend five feet into the ground. With such protection, all possible chances of personal injury to anyone working in the vicinity are eliminated.

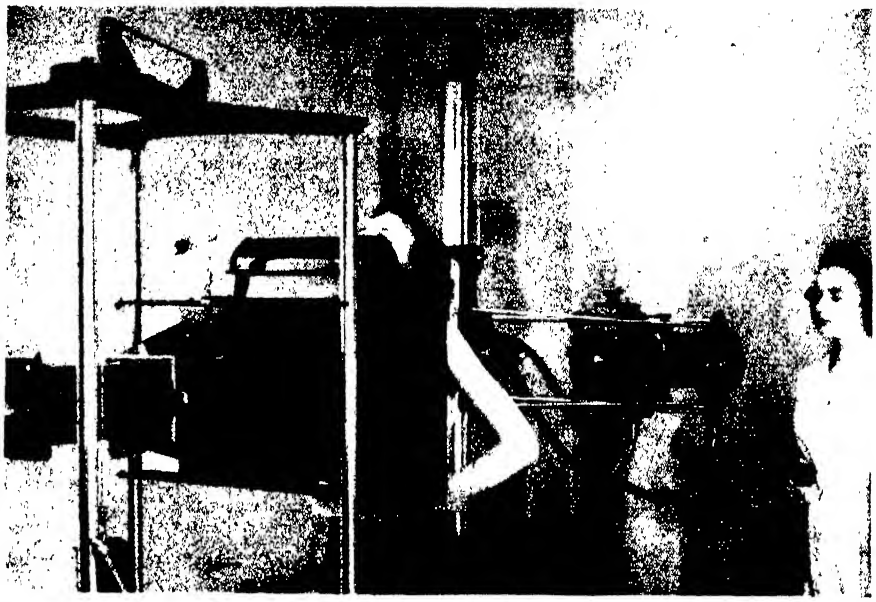
THE building itself is 100 feet long by 35 feet wide, with a huge door at one end. This door is composed of an 18-inch concrete slab encased in one-inch steel plate. In the roof is a hatchway 15 by 13 feet, with an outside gantry crane, through which can be lowered the castings of practically any commercially feasible machine. With these conveniences for bringing the work to the X-ray equipment, every advantage can be taken of the speed of operation which the high-voltage set-up makes possible.

The X-ray equipment itself—the tube and all necessary operat-

ing devices—is contained in a cylindrical tank suspended from the rails of a crane that travels the length of the building. It can be moved horizontally or vertically, and also rotated, to place it in the most convenient position for the particular work to be done.

When the million-volt tube is in operation, all persons are excluded from the room, remote controls being provided so that the work can be regulated as needed. A periscope at the controlling switchboard enables the operator to make a visual check.

Because X-rays are still somewhat of a mystery—knowledge of them is by no means complete—General Electric engineers are taking advantage of this newest ray generator to add to the sum total. Around the walls of the X-ray room are placed small sections of film, sealed from visible light. After the tube has been used for a casting inspection, these films are removed, developed. Knowing where each film was located in relation to the tube, technicians chart the paths of the rays, note any departure from what is considered to be standard behavior. Additionally, men working around the building carry small sealed films on wrist straps. Periodically these films are sent to the company's medical department to determine whether the operators are receiving any exposure to the rays.



***Above:* Taking "miniature" X-ray films. Camera is at extreme left. *Right:* Small negatives, on table, compared with conventional size films in background.**

High penetrating power is not always the most desirable factor for certain types of X-ray work. Sometimes, for illustration, moderate penetration is all that is required, while high speed of exposure is the goal. One new development, in which X-ray photographs are obtained of a human body in 1/60 of a second, is considered to be a marked contribution to medical science. This particular machine, working at a voltage of 100,000, is equipped, according to Westinghouse engineers, with a 20-cell electrical "brain" which thinks and acts with speed and precision. Strictly speaking, the brain cells are electric relays that, once the equipment is set, function automatically and cause the machine to go through a series of intricate operations, of which the taking of the X-ray picture is only one.

High-speed X-rays of golf club and ball during impact

Not only can this X-ray set-up take high-speed photographs, but it can also produce stereoscopic pictures, an obvious advantage to the medical profession, permitting, as it does, an X-ray view in three dimensions of any desired organ or limb. After the operator sets the simple controls for voltage, current, and exposure time, the machine does the rest. The operator has only to squeeze a trigger

Preliminary adjustment of the apparatus for taking stereoscopic X-ray photographs

and the electrical "brain" raises the voltage to the set value, makes the X-ray tube ready for use, and prepares the stereoscopic apparatus for operation. Pressure on a second trigger touches off another set of the relays, which makes a single exposure, moves the film, adjusts the angle of the tube to obtain the stereoscopic effect, and makes the second exposure. After this, the circuits automatically reset, ready for another cycle.

From the electrical standpoint, one of the most remarkable features of this particular X-ray setup is the fact that a current of some 200 amperes is turned on and off in the space of 1/60 of a second without the slightest arcing or burning in any part of the circuit. This is accomplished by the use of an Ignitron tube, an alternating-current operated vacuum tube that eliminates mechanical contacts which would always tend to give trouble. When this X-ray machine is operating at maximum power, 60 horsepower of energy is momentarily released. Hence the need for accurate control of the circuits. Were the power to be prematurely applied, an X-ray tube worth $1000 would be completely ruined.

While exposures of 1/60 of a second are considered to be the highest practical for medical use, there are other purposes for which even higher speeds are desired. For example, much can be learned about the action that takes place when a rifle bullet penetrates a solid object, if the X-ray picture can be taken at sufficiently high speeds to "stop" motion. Just this has been done.

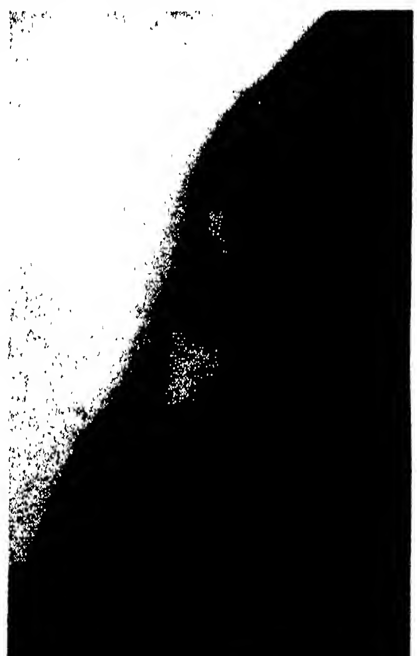
In the conventional X-ray tube there are two major elements — the cathode, from which electrons are emitted, and the anode or target, at which these electrons are aimed. When the electrons strike the target, the X-rays are emitted. In the new high-speed tube, a third element has been added. This is an auxiliary electrode which serves to start the discharge of electrons, acting as a trigger. In operation, the high-speed tube is energized from a bank of condensers that have been charged to about 90,000 volts. The circuit is so arranged, however, that even after the condensers have been charged to the desired voltage they cannot discharge their current through the X-ray tube until an additional, although small, electrical impulse is provided.

This impulse is created by breaking the timing circuit, whereupon the slight addition to the main voltage in the condensers is sufficient to energize the tube. Therefore the timing circuit is so arranged that the action to be photographed serves to make the necessary break. A rifle bullet, a flying golf ball, any similar moving object, breaks a strand of fine tungsten wire which, in turn, interrupts the timing circuit. The needed impulse is created, the condensers discharge through the X-ray tube, and the exposure is made. The tube receives a momentary jolt equal to about 2000 amperes at a pressure of some 90,000 volts, but only for a millionth of a second. So powerful are the X-rays thus generated, so fast is the photographic film employed, that in this tiny fragment of time the moving object is, to all practical purposes, stopped in its tracks and X-rayed in exactly the position that it happens to be in at the time of breaking the circuit.

Most of the work so far discussed involves the co-operation of photography and X-rays. It must be understood, however, that the penetrating effects of the rays can be rendered directly visible without the intermediary of the photographic film. If X-rays are permitted to impinge on a screen coated with certain chemicals, that screen will fluoresce or glow in direct proportion to the power of the rays. Thus, if an object is interposed between the source of the rays and the screen, an image of the object will be seen on the fluorescent surface. And this image will, within the limitations of X-ray penetration, reveal the internal structure of the object. The screen is known as the fluoroscope and is widely used where only cursory study of an object is desired, or where there is no need of making a permanent photographic record.

In the past it has been common X-ray photographic practice to make full-size negatives, with consequent high cost, difficulties of handling, bulk in filing, and so on. This, of course, was made necessary by the technique; no camera is used in conventional X-ray photography. The object is merely placed between the ray source and the negative and the exposure is made. Attempts have been made in the past to hurdle the obstacles of large-size negatives by photographing the image on the screen of the fluoroscope, but only very recently have these attempts been successful.

Several factors limit this photographic endeavor. The fluorescent



Lead spots on a contact spectacle lens serve to aid the surgeon in locating position of foreign bodies in the eyeball

screen must have maximum brilliancy, the photographic film must be highly sensitive to the color of the screen, the camera lens must be fast. After much experimental work the first two of these problems have been solved and special lenses of wide aperture have been designed and ground. Net result is that it is now possible to photograph the image on a fluorescent screen, using a four- by five-inch negative, and to obtain what are termed "miniature" X-ray films that are completely satisfactory for many purposes.

These miniature films already are being employed for group examinations in the constantly waged battle against tuberculosis. The Army has ordered a number of machines especially designed for this technique, and will use them to weed out rapidly the physically unfit among volunteers and draftees. It is stated that the cost of X-ray photographs with the miniature system is about 1/10 that of the conventional method, with the added advantages of speed of operation, ease of handling, and reduced space needed for storing the films.

OTHER new X-ray equipment of military importance includes a portable field outfit which, it is claimed, can be used to examine wounded soldiers at the rate of one a minute, thus speeding up tremendously the location of bullets or shell fragments in the body. Major A. A. deLorimer, inventor of the unit and Director of Roentgenology at the Army Medical School, Washington, D. C., states that the equipment can be set up in 10 minutes in the field and put in immediate use. In actual practice, regulation army stretchers will serve as the table top for the X-ray unit, the stretcher bearing the patient being placed directly on the frame of the unit and removed after the examination is made. This makes it unnecessary to disturb the wounded man and increases the speed with which the examinations are made.

Interesting as an example of the ingenuity employed in making X-rays of even greater service to humanity is the eye "mapping" method of Dr. Raymond L. Pfeiffer of the Eye Institute of Presbyterian Medical Center, New York City, recently announced by Westinghouse. By this system it is possible not only to detect the presence of splinters imbedded in the eye, but also to locate their exact position. A contact lens is placed over the injured eyeball. On the lens are four lead dots. X-ray photographs reveal the splinter and also record the dots, thus showing the relative positions of each, and make it possible for the surgeon to determine just what procedure must be followed for best results. Two exposures are made, one from the front of the head and one in profile, the two negatives, taken together, making it possible to obtain highly precise measurements.

What will be the next forward step in X-ray technology is almost anyone's guess. There is hardly a field of human endeavor that has not already been touched by these penetrating rays, yet to say that the most powerful present-day machine will not eventually be dwarfed by one of even greater magnitude would be to deny the value of the very basis of industrial progress—the research laboratory.

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Radio Changes Its Tune

How Industry Produces Crystals that Hold Broadcasting Stations on their Frequencies

H. T. RUTLEDGE

WHEN, on March 29, 1941, your favorite radio stations suddenly appear at new points on the scale of your receiver, the latest re-allocation of wave bands by the Federal Communications Commission will have been completed. Designed further to relieve congestion on the air and to make for a better all-around public service, this change in wave bands brings to the fore a little-known phase of radio work.

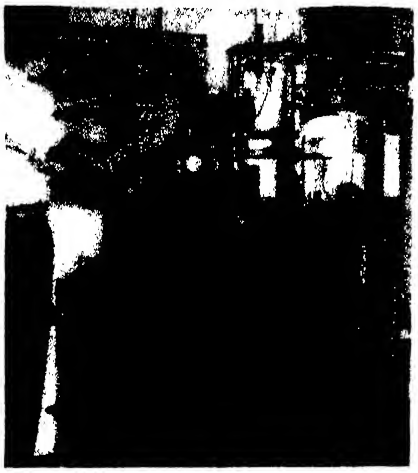
It is one thing to complete a radio transmitter and start it in operation on a specified frequency; it is quite another to keep it on that frequency for long periods of time. And if a broadcast transmitter wanders only a relatively few cycles from its assigned frequency there is immediate trouble. If nothing more, the wandering would make it impossible to obtain uniform reception. Worse still, it would probably bring about interference with some other station.

Examining raw Brazilian quartz under the light from an arc lamp

Photographs by General Electric Company

Blanks of crystal are cut with this gang-saw cutting machine

Years ago, however, a system was developed that makes it impossible for a transmitting station to wander off its wave band. Tiny crystals of quartz, ground with the precision of fine optical work, are placed in the transmitter circuit. Because of the electromechanical principle known as the Piezo-electric effect, these crystals generate small electric charges which can be used to control the frequency of another electrical circuit, holding it at a point that was determined when the crystal was ground and mounted. A number of materials



Crystal blanks, in adjustable fixtures, are oriented by X-ray reflection in this unit

exhibit the Piezo-electric effect, but crystalline quartz, because of its stability under operating conditions, is the most satisfactory. The frequency of the crystal-control circuit depends on the cut of the crystal, its dimensions, the temperature at which it operates, the design of its holder, and the constants of the rest of the circuit.

It is important that radio control crystals be ground to uniform thickness and with faces parallel to within a few millionths of an inch. This, of course, necessitates the use of optical measuring methods, as no mechanical means is sufficiently accurate. Further, for the day-and-night service required for broadcasting operation, the crystal must have long life; this is dependent on the quality of the raw quartz from which the crystals are cut. Defective crystals, if they operate at all, will soon become useless.

A crystal is ground to the correct angle, ready for finishing

Accompanying photographs show some of the important steps in the manufacture of control crystals for radio use. These crystals vary in thickness from 1/8 to 1/40 of an inch and are from 3/4 to 1 1/4 inches square. When completely finished they are mounted in sealed containers ready for use. In operation, the temperature of the crystal usually is held to close limits by means of thermostatically controlled electrical circuits, since changes in temperature affect the frequency characteristics of the crystal.

First step in the production of crystals is the inspection of the raw quartz for imperfections. Light from an arc lamp is directed against the large rough crystals at an angle and reveals cracks, inclusions, and other defects that would affect the operation of a finished control crystal. The defective portions are marked, and the way in which the crystal is to be be cut up is determined so as to obtain the greatest number of blanks from each raw chunk. Since the arc light will not reveal all defects, this inspection is supplemented by polarized light, under which "twinning" of the quartz crystal is detected.

Finished crystal, ready for its mounting in which it will control accurately the frequency of a radio broadcasting station

After the usable and the defective parts of the raw crystals are determined, the raw pieces are mounted and cut with revolving metal disks charged with Carborundum grains. In this step the defective parts are rejected and the remainder is cut into hexagonal pieces at approximately the correct angle. This angle is determined by the natural axes of the raw quartz and must be highly accurate in the finished crystal. The hexagonal pieces are now cut into bars and the bars again cut into thin slices or blanks. This work is all accomplished with metal disks and at all times the angle of cut is kept as near as possible to the predetermined value.

The blanks are now placed in adjustable fixtures and are oriented by means of X-rays. With the blanks properly held in the path of the X-rays, the technician can determine the exact angle at which the grinding operations must be conducted. Once this factor has been fixed, the crystals, sometimes in groups and sometimes singly, are subjected to a series of grindings that produce the necessary parallelism of the faces.

Grinding is followed by processes of machine and hand lapping, the final step being accomplished by highly skilled workers who are not guided by blue-prints or other set instructions but who work by cut-and-try methods acquired after years of experience. As these men work, they constantly test the crystal blanks with oscillator circuits to determine their rate of progress.

After final test for accuracy of frequency, the crystals are mounted, ready for use in the circuits of radio transmitters.

At present, regulations of the Federal Communications Commission require that a standard broadcasting station maintain its assigned frequency within limits of plus-or-minus 50 cycles; after January 1942, this standard of performance will be raised to plus-or-minus 20 cycles. The control crystal manufacturers, however, have established their own standards and even today are producing crystals that will operate continuously well within these limits.

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BRAKE LININGS

"Synthetic" — of Rubber and Small Wires

In an effort to overcome the disadvantages of a limited supply of asbestos, Germany is making automobile brake lining from a mixture of synthetic rubber bonded with tiny aluminum fibers. The rubber is a high - temperature - resistant Buna, and the aluminum reinforcement is in the form of tiny wires only 0.03mm in diameter.

The first experiments to make Germany independent of asbestos linings led to all-metal shoes, but the Buna-and-aluminum combination provides equal braking efficiency without the severe wear encountered by steel-on-steel.

This brake lining is also being used, it is claimed, with certain modifications, on railway equipment.—*Aluminum News-Letter.*

TUBE MAKER

Machine Automatically Shapes Tubes

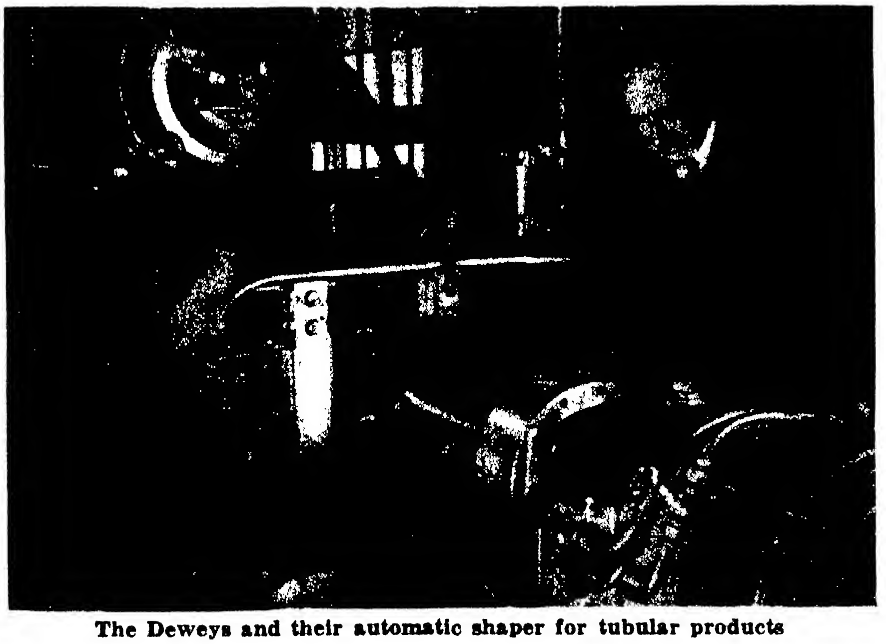
WITH the demand for aircraft parts skyrocketing in step with the national-defense program, the Steel & Tubes Division of Republic Steel Corporation is now making landing-gear struts, aileron torque-tubes, and other parts on a new machine which automatically shapes tubular products to practically any contour that could be machined from solid stock.

The machine, developed by Clarence L. Dewey and his son, Sydney L. Dewey, who have given full time to its development for the past six years, provides accurate control of wall thickness so that it is possible to turn out aircraft parts of maximum strength at minimum weight.

The 65-foot long machine, now in operation in Cleveland, is the one and only built thus far and is working two shifts exclusively on aircraft parts. However, the process will have an important bearing on the production of tubular furniture, lamps, automotive parts, tools, and numerous musical instruments.

The process has wide application in the shaping of light and heavy gage tubes of different metals at high speed. Welded or seamless tubing of any given diameter and thickness can be shaped for any required use, with the wall thickness under accurate control. This is made thicker, thinner, or held to the original thickness in the reduced section by working the tube with selected rolls under variable tension load.

Shaping is accomplished by the rolls in a moving carriage which travels horizontally along the tube, one end of which is anchored to a rotating chuck, while the other is driven by a power unit which is moved to accommodate elongations and to control the thickness. The shape is controlled by a cam parallel to the tube which moves the forming rolls to, or away from, the tube itself.


The Deweys and their automatic shaper for tubular products

RAYON

Production—and A New "Wool" Type

RAYON production in the United States during 1940 reached a record all-time high, estimates placing production at 460,000,000 pounds. This was 20 percent above 1939, which in turn was 3 percent over 1938.

Staple fiber, which differs from ordinary yarn in that the filaments are not continuous, jumped in production by 51 percent.

During the year, Du Pont developed a new rayon fiber with a high degree of permanent crimp. This new fiber, as yet known only by its laboratory name of "Fiber D," has characteristics formerly available only in wool, and it is therefore of particular interest to rug and carpet weavers. It is said also to show promising potentialities in upholstery materials, wall coverings, and plushes.

WATER-WHITE GLASS

New Plate Transmits 91 Percent of Light

GLASS technology has given us in recent years flame-proof, shock-proof, and safety glass, and glass sandwiches that aid greatly in the safety of automobile windows. Now the Pittsburgh Plate Glass Company has developed water-white plate glass which transmits far more light than any plate glass hitherto made. It is especially adaptable for multiple glazing, as in refrigerator cases, and may be used also for double glazing in connection with air conditioning and insulating installations.

The new glass is so clear, according to William J. Aull, Jr., that one can look through a 24-inch light of it, edgewise, and see an object almost as clearly and distinctly as though the glass were not there. Its total transmission of visible light is 91 percent, a figure that approaches the maximum possible. In addition, transmission of all colors in the visible spectrum is almost uniform, its transmission of the violet and blue rays being much higher than that of ordinary plate glass.

CHRONOSCOPE

Times Split Seconds Of Bullet's Flight

SPLIT seconds that are ages to a bullet or a camera shutter, are measured as easily as a wrist-watch measures the time of day by a new device called a chronoscope, developed by the Research Division of the Remington Arms Company.

The device, built into a portable cabinet, splits the second 1000 ways and will measure from one up to 200 of these milli-seconds with less than 1 percent error. Given an electrical impulse at beginning and end of an event, it can be clocked.

It has already proved valuable

for studying the effect of velocity and flight time of bullets on accuracy, range, trajectory, and hitting power, but its use is not confined to ballistics.

The maximum swing of an indicating needle across a scale tells the operator precisely how long it takes a fuse to blow out, a Photoflash bulb to light up, a telephone

Clocks bullet speeds

relay switch to snap, or a blasting cap to go off. Experimental gunsmiths using the instrument can make velocity measurements heretofore possible only in well equipped ballistic laboratories.

Projectile velocities can be measured accurately over distances as short as five or ten feet. "Remaining velocity" can be measured after the projectile has travelled some distance. The actual velocity at 100 or 500 yards, for instance, can be measured in a ten-foot span.

Remington technologists regard the instrument as a marked advance over the Boulenge chronograph, standard ballistic device, which has satisfactory accuracy on intervals of the order of 100 milli-seconds, but errs excessively on those of the order of 10 milli-seconds.

GIANT TOOL

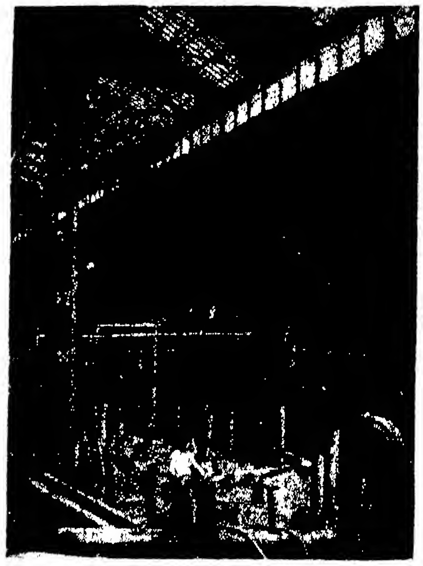
Cuts Fourteen Miles Of Steel an Hour

A 350-TON machine, capable of cutting 14 miles of steel shavings from a 500-ton piece of steel in a single hour, went to work recently at the East Pittsburgh Division of the Westinghouse Electric & Manufacturing Company to speed up production of large waterwheel generators and other power equipment required under the national-defense program.

One of the largest boring mills in the world, the machine supports its work pieces on an 88-ton turntable while two special steel, chisel-like tools do the cutting—like a phonograph needle moving across a record. Eleven freight cars were required to deliver its parts from the works of the machine tool manufacturer.

A pit large enough to hold four six-room houses had to be dug in the generator manufacturing aisle to make room for the machine's 24-ton foundation of steel and concrete. But despite its mass, this new steel Titan makes its cuts with an accuracy of four thousandths of an inch, performing on giant-sized machine parts the work of a fine watchmaker's lathe.

The tools of the boring mill can



Foundation of 125 steel piles, driven 29 feet into the earth, was necessary to support the 88-ton boring-mill turntable

cut a spiral path across the top of a steel disk as it turns on the table, or operate vertically on the sides of steel pieces. The boring mill's normal precision of four thousandths of an inch can be increased by controlling temperature conditions to prevent contraction and expansion. The machining of a steel piece often takes days, while the steel expands during daytime heat and contracts at night. When Westinghouse machined the "horseshoe" bearing for the 200-inch Mount Palomar Telescope, accuracy was improved by working on the piece for only a few hours during the night, during which the temperature changed very little.

Largest of the mill's 34 electric motors are the two 300-horsepower units which drive the table; smallest are the two one-half horsepower midgets which "float" the table by pumping lubricating oil into the grooves between the table and its circular track.

The 30-foot turntable of the boring mill described was cut in two parts for shipping on a special 200-ton freight car. Approximately 1300 cubic yards of dirt were removed for foundation pit

NYLON FOR RACQUETS

NYLON, which has found many uses in fields other than that of hosiery, now becomes racquet strings. This has been made possible by the development of a new "giant" strand, nearly one sixteenth of an inch in diameter. Since this material is practically unaffected by atmospheric changes, it will wear better than silk or gut strings. Since, further, it is a solid piece all the way through, it will not fray and therefore will require no waxing or shellac treatment.

INDUSTRIAL TRENDS

RUBBER'S ROLE

When discussion turns toward the part of rubber in national defense, the question frequently arises of the availability of synthetic rubbers and how they can replace or supplement natural rubber. Present-day trends in the rubber industry, as a whole, can serve as a basis for estimating what will be done with synthetics in the near future.

In 1940, the consumption of crude rubber in the United States was approximately 615,000 long tons, a rise of some 4 percent over 1939. In 1939, there were consumed 1700 long tons of synthetic rubbers of all kinds, a figure which was stepped up to an estimated 3400 long tons in 1940. The present outlook indicates that about 650,000 long tons of rubber will be required to fill orders during 1941; of this total there is a probability that 9000 to 10,000 long tons will be taken care of by synthetics.

Manufacturers of synthetics are naturally secretive about future plans; enough information is available, however, to venture an estimate that by the end of 1941 they will be in a position to produce on a basis of 20,000 long tons annually. Much depends, of course, on a rumored RFC loan of $25,000,000 to $50,000,000 to be applied to synthetic-rubber manufacture.

While the figures—past, present, and estimated future—do not show synthetic rubbers as serious competitors of natural rubber, there are many places in the scheme of things, both in normal consumption and in national defense preparations, where certain characteristics of the synthetics make them not only competitors but highly desirable substitutes. Some of the oil-resistant and antioxidation qualities of synthetics, for example, fit them for use in places where natural rubbers cannot be used satisfactorily or are subject to constant and costly replacement.

Rubber consumption for military purposes involves far more than tires for vehicles; it is in these additional fields that synthetics hold the greatest promise. Flexible hose for many uses, gas mask parts, self-sealing airplane fuel tanks, airplane de-icers—the list is a far longer and more imposing one than could be itemized here. In this list, however, are implications of important outlets for the synthetics—implications that will, more and more, become realities as production of synthetics gets into stride.

IN THE BUILDING TRADES

Increasing prices for lumber and millwork, due to a variety of reasons, provide attractive opportunity for other building materials. Coming at a time when building construction all over the nation is on the upgrade, these higher prices for one of man's oldest building materials make it possible to turn to other sources which, under different circumstances, might be ruled out on grounds of immediate economy.

Brick, steel, cinder block, glass, plastics, all are usually higher in first cost than wood, although under most conditions they are more economical when permanency of the finished structure is considered.

Here is a case where increasing costs in one branch of an industry will undoubtedly react to the detriment of that branch; at the same time, products of science and technology are available to fill the gap that has been created. With the gap yawning for attention, there is every reason to believe that research men will soon close it, and, in the closing, will give added impetus to the use of a wide range of materials hitherto in the luxury class.

POWER INCREASES

As industries in general expand their operations, demands for electrical power climb; with increasing demands comes the need for power-plant expansion. Last peak year for expenditures for new steam-generating plants and equipment was 1924, during a period of vast industrial expansion; 1940 came close to equalling the 270 millions which were invested during that year. Estimates for 1941 indicate that a new all-time high will be set with at least three-quarters of a billion dollars spent for new and improved construction.

Emblematical of this expansion of steam-produced electrical power, and indicative of a definite trend, is the world's largest high-speed turbine generator, nearing completion in the East Pittsburgh works of Westinghouse. This generator will supply sufficient current to light a million 60-watt bulbs, its 35-ton rotor being whirled at a speed of 3600 revolutions per minute by a steam-driven turbine. Steam enters the turbine at a temperature of 900 degrees, Fahrenheit, and at a pressure of 1250 pounds. So high is the steam temperature that the moving parts of the turbine glow a dull red when in operation; this fact, alone, presented a pretty problem to the turbine designers.

This turbine generating unit will be installed in the Waterside station of the Consolidated Edison Company, in New York City. Thus do engineers and scientists provide the wherewithal for industry, supplying demands and, more often, creating new potentialities long before the demand is voiced.

BLACK-OUT FOR PEACE

Exigencies of war in Europe have taught many lessons, one of them being the protection afforded by black-outs. Developments in air-conditioning and electric lighting, reported regularly in the pages of this magazine, have not only made feasible the permanently blacked-out factory building, but have shown that the windowless building holds as many advantages for peace-time operation as in time of war.

Windowless factory design has already begun in the United States, indicating a trend toward building construction in which problems of ventilation and lighting are solved on a scientific basis. Air-conditioning equipment takes care of ventilation, providing working conditions that can be accurately controlled in temperature and humidity; fluorescent tube lighting, rapidly striding to the fore because of its color characteristics and economy, is taking over the lighting problem and solving it in a thoroughly effective manner. Contributing to the growth of this type of plant construction is the development of new materials that can be produced satisfactorily only under controlled temperature and humidity.

—*The Editors*

The Railroads Are Ready

American Railroads Are Now Equipped to Meet National Defense or War Emergencies

HOLCOMBE PARKES

More power than in 1917

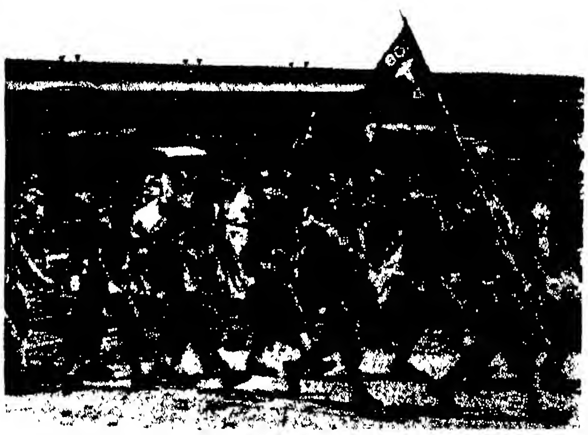
ONE significant fact stands out in all the current rush of national defense preparation. The railroads—vital link in national defense—are functioning more smoothly than ever before. In the railroad industry there is no confusion and haste to make up for lost time. Why not? Simply because the railroads are already prepared to play their role in national defense.

Do not minimize the importance of mass rail transportation in time of war, or in time of preparation against war. Most war-time governments have found it necessary to commandeer the railroads. Our own government did so in the last world war. Although there is every indication that it will not have to do so again, our railroads are perhaps more essential today than ever before. With coast lines 3000 miles apart, it might be necessary to rush troops, equipment, and supplies across the continent in either direction, a task which could be expeditiously handled only by rail transportation.

The railroads have prepared themselves against the sort of transportation confusion which resulted from our entry into the war 24 years ago. Both the railroads and the government have profited by mistakes made then. The many improvements in the railroad set-up today over that of 1917 can be classed under three heads—better equipment, more efficient operating methods, and planned organization for emergencies.

Freight locomotives today are far superior, on the average, than they were in 1917. The average tractive power of all locomotives in 1939 was 50,395 pounds, an increase of 52 percent over 1917. Locomotive design has undergone many changes to make for greater speed sustained over longer distances. Larger diameter of driving wheels, larger grate area, steam pressures of 250 or 300 pounds per square inch, and steam temperatures of 650 to 750 degrees, Fahrenheit, are some contributing factors in the evolution of the freight locomotive. Roller bearings and light-weight alloys are being used more and more. Large tenders capable of holding as much as 26 tons of coal and 22,000 gallons of water eliminate many service stops on long runs. Electric traction on the road and Diesel-electric traction in yard service have found important roles in fast and efficient freight handling.

Freight cars have likewise undergone a remodeling process. The average capacity is greater by eight tons than in 1917. Brakes, draft gears, trucks, and underframes have taken their turns at improvement. Savings in weight as high as 6½ tons per car have been realized through special features of design, welding, and the use of high-tensile steel and aluminum alloys. Cars for special uses aid shippers in transporting their goods most efficiently.



The C. M. St. P. and P. and other roads carried many troops to maneuvers last summer

Naturally, all the locomotives and cars in service are not of the latest design. Much slightly older equipment is kept in service for use in handling peak traffic loads. The railroads cannot distribute their service evenly throughout the year, but must meet demands as they come. It would be poor judgment to invest in new locomotives and cars which would stand idle many months of the year.

MUCH of the ten billion dollars which have been invested in railroad plant improvements since 1920 has gone into better tracks, modern signals, and well-planned terminal facilities. Heavier and longer rails, improved processes of cooling rails in the steel mills to eliminate defects in the metal, and welding of rail joints either before or after the rails are laid have lowered maintenance costs and increased efficiency. Curves and grades have been reduced. Stronger bridges have been built. Passing tracks—sidings—have been lengthened.

Some of the greatest railroad developments since the time of the last war have taken place in signaling operations. Automatic block signal systems have been extended and improved to keep pace with the faster tempo of modern freight train operation. Locomotive cab signals, automatic train control, and interlocking systems aid in speeding operations and eliminate, to a great extent, the possibility of human error. Centralized traffic control is a signaling development which reduces the overall time of freight trains from one to two minutes a mile over the congested lines where installations have been made.

Modern freight yard and terminal layout and equipment is an essential item in the railroads' readiness to meet emergency traf-

fic demands. Remotely controlled power switches and car retarders make it possible to break up and sort a 100-car train over the gravity hump of a modern classification yard in less than 20 minutes. Yards and equipment have been redesigned for speedier servicing of locomotives and cars en route.

Efficient operation brings benefits in two ways:

First, the time of freight in transit is shortened, with resulting savings to shippers. Between 1920 and 1939 the average speed of freight trains increased 64 percent. Whole days have been cut from freight schedules in recent years. Overnight merchandise service between points 400 and 500 miles apart is not unusual.

Second, equipment is used more intensively, with resulting savings in investment costs. In 1929, with 60,000 fewer freight cars and 5600 fewer locomotives than in 1918, the railroads handled 18 percent more carloads of freight. In fact, in nine different years after the World War they handled more traffic than in 1918, when the government had to take them over because of the transportation congestion then existing.

Outstanding achievements in operation have come through the coördinated movement of scheduled freight trains, more thorough classification of cars at major terminals to eliminate intermediate reclassification stops, and the elimination of unnecessary delays to freight trains.

The combined effect of better equipment and improved operating methods is reflected in the fact that the net ton-miles per freight train hour increased from 7303 in 1920 to 13,449 in 1939. In other words, the efficiency of railroad freight operation has just about doubled in two decades.

More efficient classification yards

By the time the government had turned the railroads back to their owners in 1920, government officials and railroad managers had learned a bitter and costly lesson—a lesson which has not been forgotten. Ever since 1920 the railroads have been planning ways in which successfully to meet the peak traffic demands of peace-time operation and the emergency traffic demands of war-time operation. Events during the past year and a half give every reason to believe that this planning has been thorough and that the railroad plant is adequate.

The freight train of today stands as a symbol of an enormously improved country-wide rail transportation service.

Photographs courtesy Association of American Railroads

To understand the preventive measures which have now been taken by the railroads, it is helpful to recount briefly the transportation mistakes of 1917 and 1918. The railroad "breakdown" did not come as the result of the inability of the railroads to carry the goods. In 1916, the railroads of the United States handled the heaviest traffic in their history up to that time. In 1917, the year the United States entered the war, railroad freight traffic increased only 9 percent. But in that year, the use of government priorities played havoc with rail transportation. Hundreds of thousands of cars of government freight were rushed to the Atlantic seaboard area, only to be held there for weeks and sometimes months because no provision had been made for unloading on arrival. At one time more than 200,000 freight cars were out of transportation service—they were being used as warehouses, with accompanying congestion of yards and terminals. The railroads did the best they could with the equipment available for transportation service. But they had no control over the issuance of priorities, and the consequent misuse of freight cars. So at the end of December, 1917, the roads were taken over by the government. In 1918, freight traffic was only 3 percent more than in 1917. In 1919, it dropped back to the level of 1916.

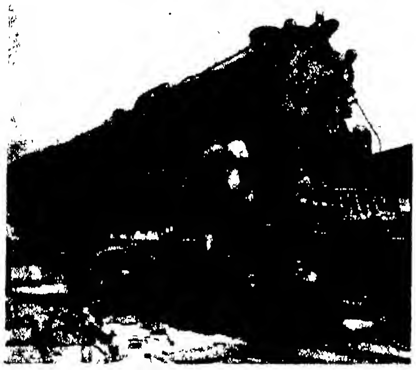
Notwithstanding other difficulties encountered under war-time operation, the railroads probably could have handled the load had there been a systematic control of car movements. There is such a control in actual service today.

Since 1922, shippers all over the country have organized themselves into 13 regional Shippers' Advisory Boards, coördinated in a national association. Through these boards, 25,000 shippers regularly forecast their freight car requirements in all sections, so that the Car Service Division of the Association of American Railroads can plan to have enough cars where they are needed when they are needed. The Car Service Division, with headquarters in Washington, has 13 district offices and car service agents at all important terminals whose duty is to keep cars moving in accordance with established rules.

The Car Service Division, for a number of years, has had in operation an embargo and permit system, under which embargoes are placed against consignees who cannot unload cars promptly on arrival. These embargoes are held in force until the consignees are able to unload goods, when permits for shipments are issued by car service agents. Plans have been established under the control of the Army and Navy Munitions Board to prevent the loading of government freight until it is known that it can be unloaded promptly at destination. Where necessary, the government, through the Association of American Railroads, can arrange for the issuance of embargoes on government freight. Thus, the necessary preparations have been made to prevent the transportation confusion of 1917 and 1918.

In the last war, many freight

cars sent to eastern seaports stood under load because vessels were not available for the trans-shipment of goods. In the summer of 1939, the Port Traffic Section of the Car Service Division was established in New York. Through daily reports and the use of embargoes, this office is equipped to prevent congestion at all Atlantic and Gulf Coast ports. During the past year, export freight through the port of



Improvements have been made in train and track maintenance

New York has been as high as 85 percent of the peak traffic of the last war, yet has been handled with facilities to spare.

The Military Transportation Section is still another branch of the Car Service Division, established to coördinate railroad operations throughout the country for defense purposes. An illustration of how this section functions was given last August, when in the space of a few days the railroads carried 150,000 troops and their equipment to army maneuver areas. Car service field agents and railroad traffic officers informed the Military Transport Section of troop train movements by telegrams which were sometimes received at the rate of one a minute. This information was relayed to the Quartermaster General's Office where movements of 300 trains, day and night, were shown on a large wall map. By keeping in such accurate touch with train movements, the troops could have been quickly diverted had the necessity arisen. In one three-day period, nearly one-sixth as many troops were moved as *in the peak month of the World War*. This movement was consummated without delay or congestion, during the summer period of heavy tourist traffic.

The railroads have left no stone unturned in their efforts to assure the United States of a smoothly running transportation machine, whatever emergency may come. Even though statistics show that all the additional traffic which is likely to result from the national defense program is but a small fraction of the regular commercial traffic, railroad men are taking no chances. Class I railroads, in the first nine months of 1940, placed in service 52,685 new freight cars and 265 new locomotives, while orders for 16,892 freight cars and 215 locomotives were outstanding on the first of October.

No higher compliment could be paid the railroad industry than that expressed by Louis Johnson, as Assistant Secretary of War, in an address on April 26, 1940. He said:

"We, in the War Department, have full confidence in the innate capacity, in the co-operative spirit, in the ability, and the patriotism of our railroads to cope successfully with the transportation problems that any grave military emergency would involve. Our faith is well founded."

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THE "JEEP"

Versatile Tractor For Army Use

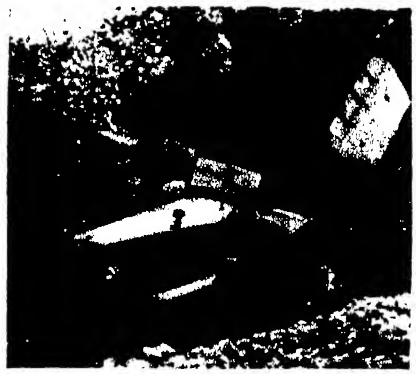
ONE of the strangest and at the same time one of the most versatile military vehicles yet tested is a tractor made by Minneapolis-Moline Power Implement Company. This tractor pulled six-inch howitzers over almost impossible terrain, through mud and water 40 inches deep, and crashed through trees four and five inches in diameter, reports *Ethyl News*. Furthermore, it virtually climbed the trunks of trees 28 inches in circumference to heights of 70 inches, at which point its weight was sufficient to break the tree.

This tractor was designated merely as a military high-speed

The "Jeep" can climb trees

Amphibious, it fords streams

prime mover, but the Army boys were quick to christen it the "Jeep." It is powered with a standard 6-cylinder engine, develops 75 horsepower, and will tow heavy equipment at 40 miles an hour on the level. It operates on 70 octane gasoline and is a four-wheel drive vehicle with two front and four rear tires, the front ones being 8.25



Rolls over rough terrain

by 20 and the rear 11.25 by 36—all low-pressure pneumatic.

The "Jeep" is provided with both air and electric brakes for controlling the towed load. The drawbar at the rear is equipped with an air lift which makes it possible to back into a load and lift or lower that load from the operator's seat.

TWO NAVIES

Comparison of U. S. and Japanese Navies

MANY years ago, Admiral Mahan, whose books on naval subjects are studied by the navies of the world, said that if we should ever fight Japan we would need four times the naval tonnage of that nation in order to be victorious. Many things have happened to modify this situation—if, indeed, Admiral Mahan did not exaggerate it in the first place. It is still serious enough, however, for any war with Japan would have to be fought on Japan's home waters. Because of the dis-

Navy	Category	Built	Building	Total
U. S.	Battleships	15	17	32
Japan	"	10	8*	18*
U. S.	Aircraft Carriers	6	12	18
Japan	" "	7	3	10
U. S.	Cruisers	37	48	85
Japan	"	44	6	50
U. S.	Destroyers	155	170	325
Japan	"	135	11	146
U. S.	Submarines	103	82	185
Japan	"	69	13	82

*Estimated.

tances our ships would have to travel and because of our present lack of sufficient bases in the Pacific, the accompanying comparison of two navies is signficant.

Five 35,000-ton Japanese battleships, each carrying nine guns of at least 16-inch size, are scheduled to go into commission in 1941. Two more, of the *Owari* class, will be commissioned in 1942. These two are believed to be the first of the super-ship type of 40,000 tons each.

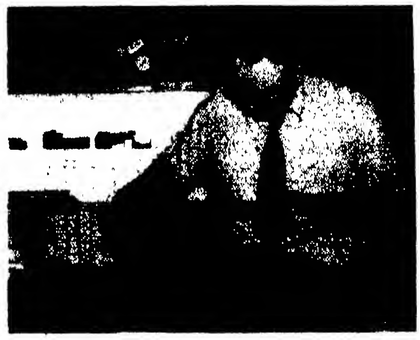
The U. S. Navy, in 1941, will commission the *North Carolina* and the *Washington*. In 1942, four more —the *Alabama, Indiana, Massachusetts,* and *South Dakota*—will go into service. All six of these are of about 35,000 tons. The first of our 45,000-tonners—the *Iowa, New Jersey, Missouri,* and *Wisconsin* —will not be ready until 1943.

SUB-MACHINE GUN

Lighter Weight, Lower Cost, Mass Production

PRODUCTION is now under way at Harrington & Richardson Arms Co. on a new sub-machine gun, invented by Eugene G. Reising, capable of all the fire power and effectiveness of the existing accepted military type but weighing 50 percent less and costing approximately 60 percent less.

Until recently, heavier sub-machine guns have been adequate to command an area at short and moderate ranges, but military authorities now hold that more intensive distribution of this lighter type of weapon among the troops is tactically desirable. The Reising



Assembling Reising gun

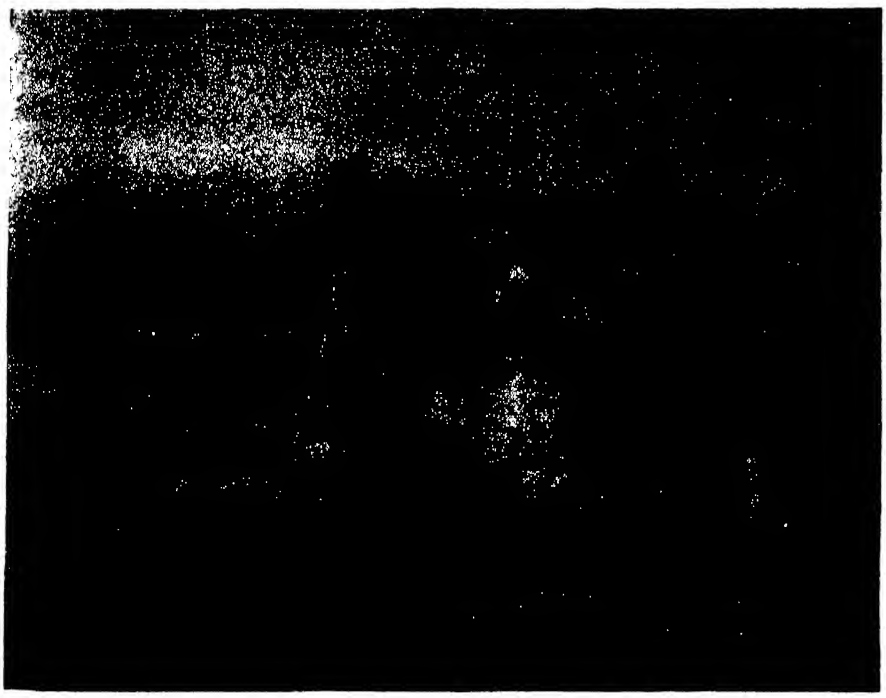
sub-machine gun, developed to meet this need, incorporates such additional advantages as use of a patented, delayed-recoil mechanism, minimizing recoil and permitting fully automatic firing from any position.

The Reising gun can fire approximately 500 shots per minute at an

Weighs little, fast in action

effective range up to 300 yards, and weighs only 6½ pounds.

Mass-production methods, previously considered impossible for an arm of this kind, will produce 1000 a day by April 1, if present expectations are realized.



The U. S. S. *Navajo,* which will have two sister ships

NAVY TUGS

Three Largest, Diesel-Electric, Ocean-Going

NOT long ago the United States Navy commissioned its first seagoing tug in 20 years. This tug, the U. S. S. *Navajo*, is to be followed by two sister ships, the *Seminole* and the *Cherokee*. These three tugs are the largest Diesel-electric tugs in the world, being 205 feet overall. Main and auxiliary generators as well as propulsion motors and control were furnished by General Electric. The tugs each have four main Diesel engines totalling 3800 horsepower. A 600-kilowatt generator is direct-connected to each of the Diesels.

Wah—Late of Thebes, Egypt

When Used on a 4000-year-old Mummy the X-rays Unexpectedly Reveal a Human Story

H. E. WINLOCK

Director Emeritus, Metropolitan Museum of Art, New York

The digging in Egypt was about over, in March, 1920, when our men unexpectedly struck the buried entrance of a little tomb. Rough steps going down had been successfully hidden with shale chips, and the little tomb door was still blocked with a stout brick wall, but once that had been removed we found ourselves in a narrow, rock-cut room which no one had seen for nearly 40 centuries. At the back there was a coffin bearing the name of a certain Wah, and in it, under a pile of laundered bed linen, lay a mummy with wrappings still as fresh as the day it had been buried.

The meal of beer and bread and meat beside the coffin was so simple, and so were the few objects in the coffin, that there seemed little likelihood of there being anything of value inside Wah's bandages. Furthermore, we had found his title written in ink on some of the bed sheets and knew that he was simply an "estate manager," and since this was not the sort of person who might be expected to be buried with jewels, so far as our experience went, it was decided not to unwrap him but to show his mummy in the Museum, just as it was found.

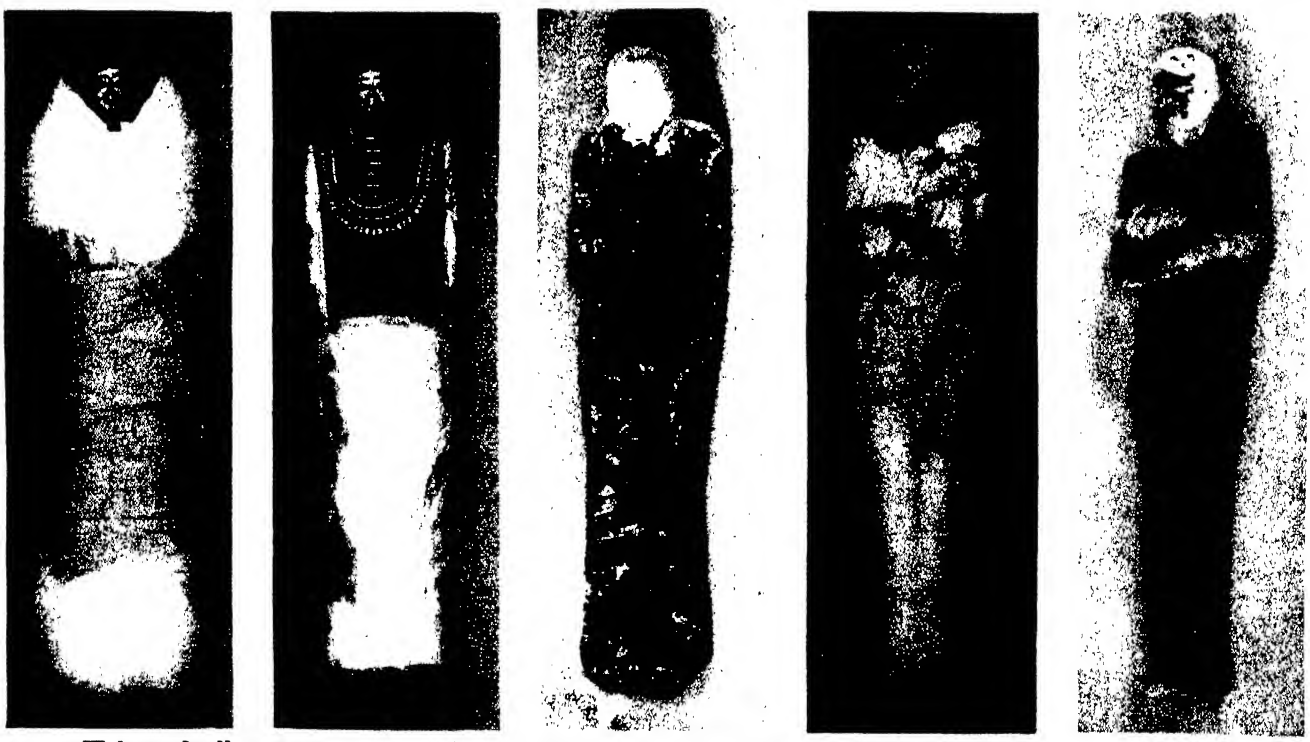
Reprinted from *Bulletin of the Metropolitan Museum of Art*

For years the mummy of Wah had been on exhibition in the Metropolitan Museum of Art, New York, when it was used in some experiments with an X-ray apparatus. The first photograph gave us a sudden surprise. From Wah's neck, down over his chest, and about his wrists crossed in front, there was a whole series of objects clear enough in the X-ray to be easily identified. We could recognize strings of beads around his neck, a broad bead collar over his breast, bracelets and anklets on his arms and legs, and some extraordinarily large scarabs near his wrists.

The outermost piece of linen on Wah's mummy was a shawl, wrapped kilt-like about him, with its fringed edge around his waist tucked in in front. It had often been to the laundry; it is pink now but had doubtless once been a henna red; and down the front are two very washed-out lines of hieroglyphs, written in black, which read: "Linen of the temple protecting Nytankh-Sekhmet, the justified."

After we had taken off the kilt we unwound a dozen bandages spiraling up and down the mummy, each about as wide as one's hand and several nearly 12 meters long. Then came sheets wrapped around, or big pieces of linen folded as pads and laid on to fill the mummy out until it was practically a cylinder. Later we came to a layer of bandages streaked with the very thin dregs of a pot of resin, probably smeared on with incantations for Wah's continued existence, for its purpose must have been magic —it could have had no preservative effect. A score more of sheets and pads were then unwrapped, and Wah, from having been a very stout party, was becoming more and more slender, and the face which had been peeking out of thick folds of linen now appeared as part of a stucco mask extending down to his waist.

The pinched little face was



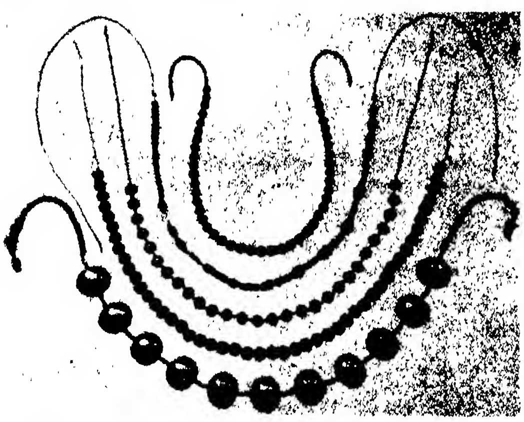
Wah gradually emerges as enough wrappings to cover a building lot are removed from his small body

gilded, and on it were painted a thin moustache and, around the jowls, scant whiskers. A highly conventionalized wig, striped light blue and dark green, covered the head, and a crudely painted broad collar with red, blue, and green rows of beads was shown suspended on the brown chest. It was a barbarous-looking affair, but, after all, Thebes was still a rather countrified, Upper Egyptian town when Wah died, and this mask was clearly bought from one of the more old-fashioned of the local artisans.

One of the two silver scarabs. Its length is 38.5 millimeters

When we had taken off the mask and ten more sheets and pads, we came to another layer of resin, thick and black this time, poured all over the front of the body except the head and face. When we had removed it, the bandages it had penetrated, and another dozen sheets and pads, we came to the first of Wah's jewelry.

There were four bead necklaces, each with its cords tied behind the nape of his neck. There was a string of 11 big, hollow, silver spheroid beads separated by little cylinders, and another string of 28 smaller ones of gold. A third string was of 48 blue faience ball beads, and a fourth of 28 cylindrical and oval beads of carnelian, amethyst, moss agate, milky quartz, black and white porphyry, and green glazed steatite. The dents in the hollow metal beads and the fraying of the cords of the silver and of the faience necklaces show that at least three of these strings had actually been worn by Wah or by some of his family, just as we see them today.



The jewelry from Wah's mummy, as exhibited at the Metropolitan Museum

Half a dozen more bandages and pads and then we came to more jewelry. Another string of 45 deep blue faience ball beads had simply been bundled together and laid on the mummy's chest, and over his crossed arms there had been placed four large scarabs. One was of plain blue faience, about an inch long, without any inscription or other device. The other three are among the surprises of our Egyptian work.

Two are of massive silver and the third of lapis lazuli. The larger silver scarab is an inch and a half long. Each was made up of separate pieces, molded and chased and then soldered together—a head and back plate, legs, and a flat base, with a gold tube for a cord fastened lengthwise through the middle. The lapis lazuli scarab is nearly an inch and a half long and perfectly plain, but on the bases of the two silver ones there are graceful, meandering scrolls interspersed with hieroglyphs which made easily recognizable seal devices. Both silver scarabs were oxidized, and when we began to clean the larger one we found heiroglyphs skilfully inlaid on its back in pale gold, those on the one wing reading, "The Prince Meket-Re," and on the other, "The Estate Manager Wah"—the names of the owner of the scarab and the grandee for whom he worked. The scratches and dents on the polished surfaces of this silver seal scarab and its smaller mate, and the wear in their gold string-holes, showed that they had seen real use. But it was surprising to find that just before they had been put on the mummy the faces of both the silver scarabs and of the lapis lazuli one had been purposely and methodically hammered and pecked as though to blind them. Then, after the blinding, each scarab was strung on a stout linen cord with one barrel-shaped and one cylindrical bead, which obviously made them into amulets to protect Wah against some of the many perils of the life to come.

NEXT we unwrapped half a dozen large bandages and twice as many pads and sheets, each one more stained with resin than the last. Clearly the linen we were now taking off had been put over a third resin layer while it was still soft, and when we got down to it we found stuck fast in it a broad collar of greenish blue beads on Wah's chest and matching bracelets on his wrists and ankles. All were stiff with the resin which saturated them, and tight bandaging had crumpled up the collar, but soaking in alcohol made them all pliable once more, and their stringing needed very little reinforcement before they were ready for exhibition.

What we found so far had seen actual use in Wah's lifetime. Here we had objects made expressly for the tomb and in the style of centuries long gone by even in Wah's day, and perhaps this explains why they had been put on the body in a perfunctory and careless way. The cords of the broad collar had only been twisted together behind the nape of the neck, and not tied, and there had been a good deal of confusion over the bracelets. There were eight of these last. Two were tied on each ankle, and then, by some mistake which no one noticed, a third was put on the right ankle. Thus, when the undertakers began putting bracelets on the wrists, they had only three left, and the last of these they simply dropped on the body in the soft resin and went on with their bandaging.

We still had quantities of bandages and sheets to take off, but there was only one more object to remove. We had thought from

the X-ray that an oval seal was on a finger of the left hand, but what we actually found there was an oval *seweret* bead of red carnelian such as was usually put on the throat of a mummy. Why this one was laid in Wah's palm is still another puzzle.

While we were unwrapping the mummy we had it up on two carpenter's saw horses; the Egyptians who wrapped it probably had it up on blocks of wood while they squatted beside it on a wide wooden platform. Alongside they had great heaps of old linen bed sheets, which they tore as they needed into pieces about eight feet long or into strips of bandage of whatever width they required at the moment.

NEAR by was the resin pot, and sometimes the resin got splashed on the heap of linen and sometimes it was wiped from sticky fingers on the pile of sheets, but the embalmers were very careful not to get any on the bandages that were going to show or any pitchy fingerprints of the part of the mask that was not going to be covered up. When, however, they thought they would not be found out they showed indifference. One of them had killed a mouse while they were smearing on the last layer of resin, and the dead mouse and the linen resin swabs were dropped on the mummy's knees and hidden

The blue-green collar, found rather mussed up — perhaps Wah wasn't a popular overseer

under the next bandages. What we had taken for another mouse was much less distinct in the X-ray. It turned out to be a little house lizard, of a kind still common in Egypt, which probably ran under the mummy, got stuck in the innermost layer of soft resin, and was wrapped in the bandages. A cricket had been entrapped in the same pitch layer beside the broad bead collar, and it got wrapped in, too.

In all we unwound 375 square meters of linen from the mummy, and, if we add the sheets we found in the coffin and two pieces which had covered it in the funeral procession, the total from the tomb of Wah comes to about 9090 square feet, or nearly a quarter acre. This was old household linen, shawls and bed coverings saved against the day of need, or procured from friends and relatives, or perhaps even bought of strangers for the occasion. Linen was costly and was an important form of wealth.

In the corners of at least 60 of these sheets there had been written in ink a hieroglyphic sign or two which told its quality, and often, in the opposite corner, the owner's name. For some reason there seems to have been an objection to letting linen go to the tomb so marked, and therefore most of the little labels had been torn out. This was done during the actual wrapping of the mummy, but so carelessly that three of the torn-out corners got rolled on the mummy with the bandages, and one third of the marks were entirely overlooked and not torn out at all. Half a dozen gave the names of various people for whom they had originally been woven, and in the mark on the longest sheet of all we could just make out "Year 31," now very faded from much washing. That seems to fix the date of its weaving some 30 years before Wah died.

Eleven sheets bore the name of Wah himself. One was marked with his name only. Two were marked with his name and the date "Year 2," unquestionably of King Sankh-ka-Re, the last legitimate ruler of the Eleventh Dynasty. Then come three sheets of "Year 5," three of "Year 6," and two others without any year, all marked "The Estate Manager Wah." It looks as though it had been between the second and fifth years of Sankh-ka-Re that Wah got the job of manager of Meket-Re's estates, and as there are no higher dates than the sixth year, he probably died in the second half of the king's 12-year reign, or about 2010 B.C.

It only remained to find out what we could from the body of Wah himself, and in this we had the co-operation of Dr. Harry L. Shapiro of the American Museum of Natural History. Wah turned out to be a youngish man about 30 years old, who had undergone a primitive mummification. His brain was probably left in place, and the embalmers seem to have left his viscera intact above the diaphragm. Below that level they appear to have removed them, apparently through an incision in his lower abdomen. The more or less prolonged soaking had made Wah's flesh so soft that too tight a bandaging made a very narrow bundle of his body.

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AMERICAN PREHISTORY

Summary of Major Factors in Early Peopling of the Continent

THE New World apparently was peopled by two major migration waves out of Asia. There have been human beings in North America for approximately 15,000 years.

These are among the conclusions stated by Smithsonian Institution ethnologists in a recent major stock-taking of North American prehistory.

It is now fairly conclusive, reports Dr. T. D. Stewart, one of the ethnologists, that two different basic stocks were represented in the aboriginal population. One was characterized by long, high heads, and broad noses. This type of skull predominates in those sites which, it can be demonstrated, were settled first. Later sites yield skulls of a broad-headed people.

A few years ago it was generally believed that man was a relatively recent arrival in North America. Finds of human artifacts in geologic strata which can tentatively be dated and in association with the bones of extinct animals have forced a revision of this doctrine.

The remains are so few and scattered that the historical picture remains very confused. A broad outline is that, late in the Pleistocene geologic period, there was an ice-free corridor from the Arctic through Canada east of the Rockies by which bands of hunters were able to penetrate far to the southward. Those probably were the so-called Folsom and Yuma men whose spear points are widely found.

Later, it now appears, this corridor was closed by some fluctuation in the ice sheet and — perhaps after a long interval — other groups began coming southward west of the Rockies.

Magnetism Comes of Age

Today Science Knows that the Ultimate Key to Magnetism is the Spinning Electron

JEAN HARRINGTON

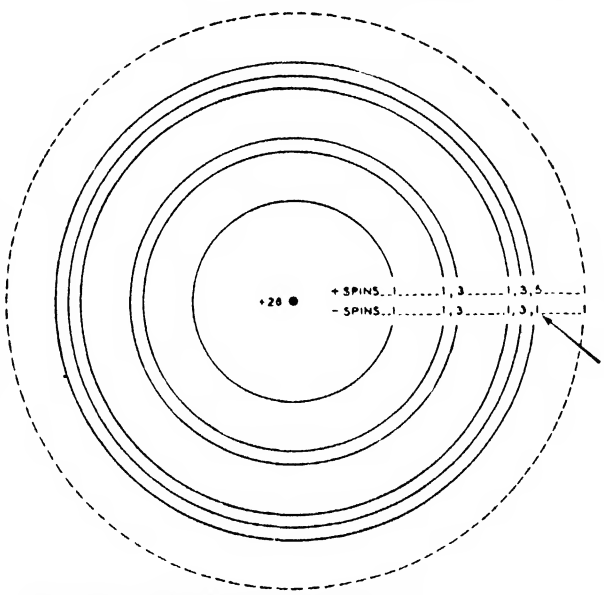
MEN have known about magnetism since before the dawn of history, but magnetism as a science has been in its adolescence until lately. The past few years, however, have seen such strides that, today, though we still don't know all the answers, we think we know enough to say that at last this science is coming of age.

There are various kinds and degrees of magnetism common to all substances, but the kind that people generally mean when they say "magnetism" is ferromagnetism. It means, literally, "magnetism similar to iron's." It means, in practice, the power of certain materials to exert strong external forces, to build up intense magnetic fields, to magnetize other susceptible bodies, or to move them. Only a few materials have this peculiar power, but their significance in your life and mine couldn't be exaggerated. Our telephone receivers, our radio loud speakers and, more fundamental, all our electrical systems that light our lamps, run our motors, or manufacture the goods we buy, are based on the use of ferromagnetic substances.

It is tremendously important for man to know a lot about these materials—how they get that way, how they vary with heat and cold, how they behave under strains and tension, how their qualities change when other materials are mixed with them. Knowing all these things, man can make more efficient machines—create, perhaps, more wonders.

Of the known ferromagnetic materials, iron, cobalt and nickel are the Big Three, and their characteristics are carried over into many of their compounds and alloys. A fourth element, one of the rare earths, gadolinium, has recently been added to the list, but it probably will prove to be of little commercial importance. Most ferromagnetic materials contain one or more of the Big Three elements, but a marriage of non-magnetic elements sometimes gives birth to a ferromagnetic alloy, proving that the Big Three aren't essential.

What, then, does iron possess that copper, for example, or lead, does not? Why ferromagnetism?



Illustrations courtesy Bell Telephone Laboratories

Electron shells in an iron atom. Arrow indicates incomplete sub-shell that causes ferromagnetism

It all goes back to the atom, so let's take a look at the atom, and particularly at the electrons that are its outer part.

If you were of a size to ride on an electron, you might feel quite at home, so alike is the geography of an atom to our own solar system. Electron "planets" whirl in orbits around a nucleus "Sun", and also spin on their own axes, just as the Earth turns about its own.

Whenever electricity is in motion (and it always is—nothing ever rests in this universe of ours), it creates a magnetic field about itself. Electrons are infinitesimal bits of negative electricity. Therefore, *q.e.d.*, every moving, spinning electron in an atom creates its own magnetic fields—one for its orbital motion, one for its spin. We can leave the orbital effect out of the present discussion, because experiment shows that it has little or nothing to do with ferromagnetism. The effect of the spin alone is enough to make each electron behave in many respects as if it were a tiny bar magnet with a north and south pole.

The spinning electron is the ultimate magnetic particle, the key to magnetism. Yet these elementary electron magnets are far too feeble to have any influence outside their own small sphere. Moreover, the atoms of all elements, ferromagnetic or not, contain these seeds of magnetism. How, then, does it happen that the tiny seeds grow to such lusty proportions in a few cases, yet are choked out in the large majority of elements?

Well, the study of ferromagnetism, as we shall see, is a study of co-operation—co-operation between electrons within atoms, between atoms in a group, and finally, between all the groups in a mass of material.

The first step is to find what magnetic effect the spinning electrons have on the atom as a whole. Often the spins add up to nothing at all. This is possible because the electron spinning clockwise cancels out the magnetic effect of a nearby electron whirling counterclockwise. Take, for example, the helium atom with its two electrons spinning in opposite (plus and minus) directions. Their two magnetic fields blot each other out; the net magnetic effect is zero, so helium is magnetically neutral.

But in ferromagnetic materials we could hardly expect to find magnetically neutral atoms. On the contrary, instead of neatly counterbalanced plus and minus spins, we anticipate a marked excess of one kind over the other. And that is just the case.

THE iron atom has 26 electrons in its outer structure, all following separate orbits around the nucleus. These orbits fall into certain groups, or shells and sub-shells, as shown in the first figure. The number of electrons with each direction of spin is marked on the drawing

for each of the several groups.

On comparing the numbers it is apparent that one of the sub-groups—the outer part of the third shell—is all out of kilter: six electrons, and five of them with plus spins. All the other groups are balanced, the spins cancelling out. But here, in effect, are four rebel electrons to give the iron atom a strong permanent magnetic effect. In cobalt, there are three extra "plus" electrons, in nickel, two.

In the case of alloys, where one metal is dissolved in another, electrons from one element drop into outer shells of the second element; and, if the new arrangement leaves unbalanced spins in the majority of atoms, the alloy has at least a possibility of being ferromagnetic. For, as long as it has excess plus or minus spins, the atom as a whole behaves like a small magnet, and this is the first requisite of ferromagnetism.

Unfortunately, lots of other atoms besides the ferromagnetic ones have permanent magnetic

Typical powder pattern, X 1000

effects—hydrogen, for example, with its lone electron. Yet hydrogen not only isn't ferromagnetic; it is magnetically neutral in the molecular state. This is because the pair of atoms in an H_2 molecule have opposite spins. So there must be some additional requisite for ferromagnetism besides atoms that act like magnets.

Now a single little atom is no good to anybody as a magnet, but when trillions of atoms all get lined up in the same direction, pulling with instead of against each other, they can lift many times their own weight, or produce the powerful magnetic fields that make our dynamos and motors run. The question is, how to get them lined up.

An important thing to remember about magnets is that they have a tendency to rotate when they are placed in the field of some other magnet. When they are free to pivot, they rotate just enough to line themselves up in the direction of the outside field. The compass works on this principle. This tendency toward rotation is termed "magnetic moment," and atoms with unbalanced electron spins are said to have permanent magnetic moments.

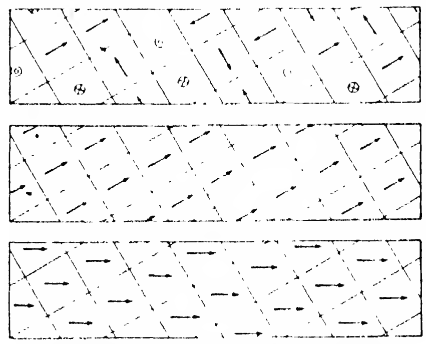
The earth, itself a gigantic though rather weak magnet, provides a universal outside field, and one might suppose that all magnetic atoms would rotate in it and line themselves up north and south, like tiny compasses. Fortunately, perhaps, this doesn't happen, or coins might fly out of our pockets and we'd run into difficulties with the steel springs of our watches and clocks. It takes a greater force than the earth's field to marshal atoms in magnetic array; in fact, it takes a stronger field than any man has been able to produce. This is because atoms are such jitterbugs. Even at ordinary temperatures and in solid materials they are vibrating and rotating like mad. Strong external fields alone are not enough to calm them down and straighten them out.

But in the ferromagnetic clan, and in it alone, there exists another force—an internal force that makes groups of neighboring atoms lie parallel to each other. This force is an abstruse thing, called an "exchange interaction." It is quite distinct from ordinary electrical or magnetic forces, and depends on such things as the radii of electron shells and the distance apart of atom centers. The exchange interaction is universal, but it can be either positive or negative. When it is negative, as for hydrogen, it tends to bring atoms of opposite spin together, resulting in non-magnetic materials. For the ferromagnetics it is positive, lining up atoms of parallel spin into sub-microscopic groups or "domains" of intense magnetization.

We can't see the domains but we know they are there. Everyone is familiar with the feathery patterns that iron filings make when they are spread on a piece of paper and held over a bar magnet. The tiny domain magnets produce the same kind of patterns when powdered iron is spread on the surface of an unmagnetized ferromagnetic crystal . . . only you have to use the microscope to see them. A typical powder pattern is shown in the photograph.

The domains, small as they are, contain billions of atoms which pool their individual magnetic moments. The result is a domain magnet, billions of times stronger than the atom magnets . . . strong enough to respond to outside fields. This is the essential difference between ferromagnetic substances and the rest of the world.

In an unmagnetized iron crystal, the domains lie all helter-skelter, pointing toward any one of the six crystal sides, as in the top part of the illustration below, where the



Domains in a single iron crystal

diagonal lines indicate the crystal axes; the circles, crosses, and arrows the domains. The arrows also indicate magnetic fields. It is a tug of war, with neither side gaining an inch on the other. But when the crystal is put in a strong enough magnetic field, the atoms within the domains begin to rotate. First they swing around until they are all parallel, as in the middle part of the figure. Then they gradually rotate till they all lie along the direction of the outside field, as in the bottom part. This final step brings the magnet to full strength or saturation. Sometimes the earth's field is strong enough to aline the domains, and that is why we have naturally occurring magnets.

The crystal can be demagnetized by reversing the direction of the outside field, or by heating the material so hot that nothing, not even the strong internal exchange forces, can make the atoms and the domains stay in line. The temperature* where this happens is called the Curie point, after Pierre Curie, who did outstanding research in magnetism before he and his famous wife discovered radium.

This has been only a sketchy account of the why of magnetism. We have seen how two fundamental conditions must be satisfied—first, that the atoms have a permanent magnetic moment, and second, that an internal force exists to hold the spins of groups of atoms parallel. There are many other factors, how-

ever, which influence magnetic properties—problems of chemical composition, methods of preparing materials, and so on—too complex to go into.

Our civilization requires many great tasks of ferromagnetism, and that is why our engineers and metallurgists, our physicists and chemists need a sound knowledge of the principles that govern it.

• • •

SOUND

By a New Method The Speed of Sound Has Been Redetermined

A NEW method for measuring the velocity of sound over short distances has been devised in which 60 pulses per second cause a sinusoidal curve to appear upon an oscilloscopic screen. As the receiving microphone is moved away from the sound oscillator, or producer, the crest of the sine wave moves across the oscilloscope. The actual velocity of the sound is easily calculated after the distance moved by the microphone has been measured.

The method has been described by R. C. Colwell, A. W. Friend, and L. H. Gibson of West Virginia University. The average of 1200 measurements made by this new method gives a velocity of sound of 331.364 meters per second at zero degrees, centigrade, or 32 degrees, Fahrenheit, and the researchers state that this is accurate within 0.043 meters per second.

NATURE LEADS

Best Light Detector Is Not Man's Invention

A CHANGE in only eight or nine molecules of the "sight chemical," visual purple, in the retina of the human eye is sufficient to produce the sensation of sight, Prof. Selig Hecht, of Columbia University, recently told the American Association for the Advancement of Science. Associated with Professor Hecht in his experiments were Simon Shlaer, also of Columbia, and Dr. Maurice H. Pirenne of the Belgian-American Educational Foundation.

In the research, an observer would stay in a dark room for half an hour, until his eyes had become dark-adapted and reached a maximum of sensitivity to light. Then a flash of light, exactly a hundredth of a second in duration and of carefully measured radiant-energy content, was shot at his eyes. The amount of light actually reaching the retina, when the minimum sight-causing illumination was reached, was calculated at eight or nine quanta, each quantum being able to cause the necessary chemical change in one molecule of visual purple in the retina.

Professor Hecht commented: "Judging by the structure of the retina, the structure of light, and the chemistry of visual purple, it is hard to conceive of a biological system which could be more sensitive than this. Certainly there are no physical systems which even approach it."—*Science Service.*

PROGRESS

Electron Microscope Is Now Ready for Industrial Use

THE electron microscope which substitutes for light a stream of electrons speeding through magnetic coils that bend their paths as a lens bends light, has already emerged from a stage described in Scientific American last July, in which it was essentially an instrument for the physicist and electrical expert alone, and has been simplified so that now it is only half as bulky (and incidentally half as expensive) and is adapted to use in general chemical and medical laboratories. No longer need it be operated by a physicist; any competent laboratory worker can use it.

Electron micrograph of human tubercle bacilli showing detail that had never been seen with visible-light microscopes

The new form was developed by James Hillier, physicist at the RCA Research Laboratories, under the direction of Dr. V. K. Zworykin, and is expected to find practical uses in virtually every field of industrial research. (See also page 133, this issue.)

With microscopes using light, magnifications of about 1500 were practicable, and at one time it was customary to *prove* that no human being would ever see the detail of any object magnified much more. The proof consisted of the simple fact that the very wave length of visible light did not afford more magnification, and that was that. The electron microscope magnifies up to 25,000 times, additional magnification being possible by photographic enlargement.

Bacteriologists, physicists and industrial laboratory research workers have journeyed to the Camden RCA research laboratories to study their specimens under the new instrument. So much more than has ever been revealed before has been made visible, that the scientists have been plunged into intensive research in new and wider fields.

Streptococcus beta haemolyticus under electron microscope. This reproduction, and one at left, were reduced from original photographs that showed magnifications of about 45,000

"Objects which have been studied under optical microscopes for years take on new form when magnified 100,000 times," Mr. Hillier says. "Portions of the organisms or particles never before noticed have to be identified, as must other objects being seen for the first time. It is as though a man blind from birth should suddenly regain his sight, only to realize that there were many new aspects to objects with which he had been familiar, but had never seen."

The extreme simplicity of the new instrument makes it ready for operation when plugged into an ordinary light socket. An adaptation of a radio transmitter circuit provides the high voltages required.

A New Tool for Science

A Noteworthy New Atlas Shows Astronomers What the Solar Spectrum is Really Like

HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

As THE writer of these lines ran through his morning mail a few weeks ago, an exciting post-card appeared. On its face, it was merely a routine announcement that packages "containing charts" and presumably subject to duty were at the Custom House in New York—and also that they had been sent from the Netherlands by Minnaert.

Here was real news. Every worker on the solar spectrum has known that an atlas of the solar spectrum was in preparation at the Utrecht Observatory by Professor Minnaert—the leading authority on the precise measurement of line-intensities—and that the work had been practically completed before the invasion of Holland. But few had dared to hope that the results could be transmitted across the barrier raised by the War and reach us in perfect condition.

Profound satisfaction in realizing that scientific communications are not completely cut off was followed by enthusiasm when the packages arrived and were opened, and the new Atlas, with its wealth of information, was inspected.

Photographic maps of the solar spectrum have been in the library of every observatory since the classic work of Rowland more than 40 years ago, and anyone who desires one for himself may get it for a few dollars by applying to the Mount Wilson Observatory for the photographs of the sun-spot spectrum, which they have on sale.

A SMALL portion of one of these photographs (in the orange region) is shown in Figure 1—the spectrum of the spot running lengthwise down the middle, with that of the undisturbed disk of the Sun above and below. The differences between the two would furnish material for two or three articles as long as this. We can only notice here that some lines are greatly strengthened in the spots, others much weakened, and a few of the strongest "winged" on each side, while the zig-zag appearance (brought out by polarizing apparatus in front of the spectrograph) reveals the presence of a magnetic field in the spot.

The undisturbed spectrum of the disk appears in comparison to be a simple affair. The stronger lines are wider and blacker than the rest, some of the fainter ones look a little fuzzy; and there are close doubles—as at 6147 and 6163. But the general impression is of sharp-edged lines ruled across a uniformly bright background.

Such photographs are admirably adapted for recording the exact positions of the spectral lines—their wavelengths—but they provide only a crude indication of their intensities. A rough-and-ready scale can easily enough be obtained by assigning numbers 1, 2, 3, and so on, to lines of increasing strength—as Rowland did. By comparing different plates, the effects of different exposure-times may be allowed for, and a scale of "intensities" reached which is fairly uniform over a range of the spectrum, and describes the appearance of the line on a properly exposed plate. But when different kinds of plates have to be used for different colors, there is likely to be a break in this scale; and, in any case, it affords us no way of knowing how much stronger a line of intensity 5, for example, is than one of intensity 1.

An accurate study of the intensities of the lines must begin afresh. The very plates should be different. For wavelength measurement, contrasty plates are used, and developed so as to emphasize the dark centers of the lines and reduce as much as possible the impression produced by the gradually shaded wings on each side. For the present purpose, plates of low contrast must be employed, and developed so as to bring out the wings. The plates are measured with a microphotometer. The image of an illuminated slit is focused on the

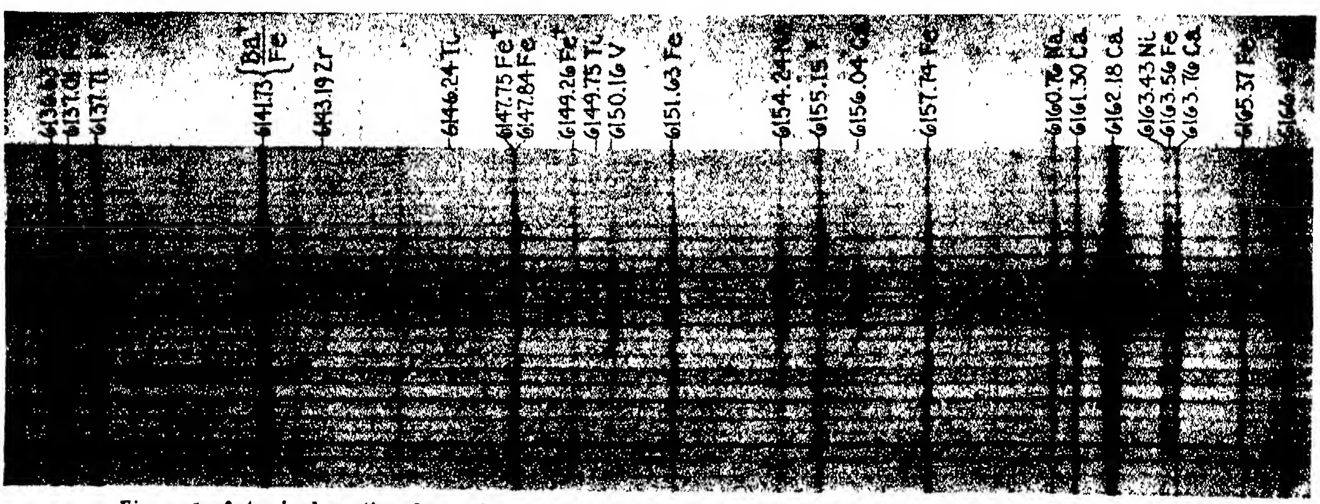


Figure 1: **A typical section from the photographic spectrum map from Mount Wilson Observatory**

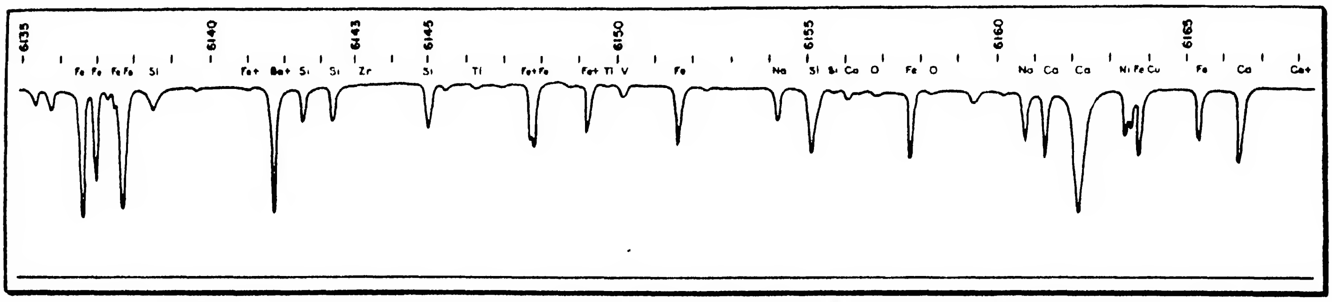


Figure 2: **A small part of the 300-foot curve of the new charts, corresponding with Figure 1**

plate, forming a very narrow bright line, parallel to the direction of the spectral lines. Since the negative is not wholly opaque, even in its densest parts, some at least of this beam passes through, to be caught by a delicate thermocouple, which sends a current to a recording galvanometer. The plate, mounted in its carriage, is slowly moved across the beam by a micrometer screw. Every time a solar line—which is dark in the spectrum, but bright on the negative—passes across the narrow beam, an increased amount of light goes through to be recorded. The record of the changing galvanometer deflections is automatically made on a strip of bromide paper, connected with the micrometer screw by gearing, so that it moves (in this instrument) just seven times as fast as the plate. The developed roll of paper will then exhibit a curve, rising highest where the film is most opaque, and with a dip upon it corresponding to the passage of each spectral line across the recording beam. The blacker the line in the spectrum of the Sun, the more nearly transparent will be the bright line on the negative, and the deeper the dip in the curve—while it will also evidently reproduce faithfully differences in the widths of the lines.

The new Atlas gives a curve of this sort. A small part of it, representing the same spectral region as Figure 1, is shown in Figure 2.

With the aid of very ingenious devices, the original photographic record was transformed in such a way that the continuous background of the spectrum, free from lines, is represented by a horizontal line, and that the depth of the curve below this at any point is proportional to the amount of light removed from the spectrum at this point. The published curve is therefore a graph showing, in extreme detail, the absorption in every part of each spectral line.

The new Atlas is a work of impressive size. The principal part, based on spectrograms taken at Mount Wilson by Dr. Mulders, extends from λ3612 in the ultra-violet to λ8771 in the infra-red. The scale is two centimeters per angstrom, so that the set of charts, if laid end to end, would be more than 100 meters long. A supplement, from spectrograms made at Utrecht, shows the ultra-violet from λ3332 to λ3637.

The work of taking and standardizing the plates must have been heavy, that of preparing the tracings no less so, and the transformation of the results to an accurate intensity scale the most troublesome task of all. The charts themselves are a masterpiece of scientific printing—the profile-curve, in black, being superposed upon a background, ruled in centimeter and millimeter squares in blue, so that the exact coördinates of any point may easily be read off. One especially pretty thing is visible only with a magnifying glass. The individual millimeter rulings are composed of fine dots, accurately spaced five to the millimeter, so that the place where the curve crosses any one of them can be read by inspection to a tenth of a millimeter or even to a twentieth.

All in all, the Atlas is a monumental work reflecting high distinction both upon the scientific workers who prepared it and the technicians who realized it in practice.

It is deeply satisfactory to know that this splendid piece of work has escaped the perils of war. Only a few copies are yet in this country, but it is expected that more will come soon.

The cost of publication must have been very heavy. It was defrayed mainly by the co-operation of a long list of institutions, mainly in Holland, so that it is being sent free to the principal observatories. It forms a noteworthy addition to the working capital of astrophysics—something that will retain its full usefulness for many years.

Let us now see how this Atlas differs from the older photographic ones. Comparing Figure 1 and Figure 2, we see that the ordinary photographs, taken for wave-length measurement, actually obscure certain important facts. Look, for example, at the three lines between 6163 and 6164. On the direct photograph these appear fully distinct, with even the two closest separated by an interval about as bright as the continuous spectrum on each side. The curve shows that these two lines, in reality, almost run together. (A still more striking example may be found at 6147.8, but the half-tone process does not resolve these lines, which are clearly separated on the original photograph.) We have to deal here with a noteworthy optical illusion. Our eyes are remarkably sensitive to contrast, and a small abrupt change in brightness impresses them far more than a smooth gradual change of greater amount. In the red end of the spectrum, the lines are fairly far apart, and this effect finds little place. In the violet, where the lines are much more numerous, we get the situation illustrated in Figure 3 (also traced from the new Atlas). The lines crowd upon one another so that it is only here and there that the unobstructed background gets clear through. In some cases, as in the violet side of the line at 4068.0, smaller lines reveal themselves, not by minima in the curve, but by "hesitations" in the steep descent. Yet, on the direct photographs, these two little wiggles in the curve appear as definite, clearly separated, dark lines, very similar to the two next to these toward the violet, which correspond to conspicuous minima in the curve.

From the direct photographs, too, one would hardly suspect that even the strong lines are so far from being black. In the orange, the strongest lines (such as 6136.6, 6141.7, 6162.2) show a residual intensity at their centers of fully 30 percent of that outside the line.

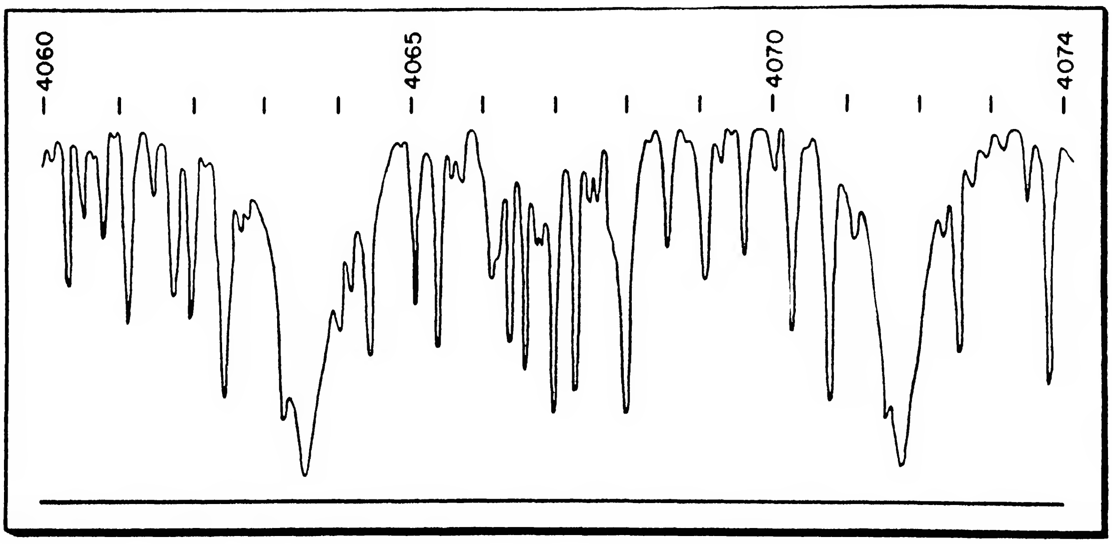


Figure 3: **Traced from the new atlas. A section taken from the violet part of the spectrum where the lines are crowded**

In the violet, the heavy lines at 4063.6 and 4071.8 are much deeper, with residual intensities of 7 and 9 percent; but these lines are very much stronger, as shown by their great width. Their wings extend far on each side and ten or a dozen neighboring lines are included within their extent.

The fainter lines, in both spectral regions, are represented only by very shallow dips in the curve. This arises partly from instrumental reasons. Powerful as is the great 75-foot spectrograph at Mount Wilson, it could not give a perfectly sharp image of an absolutely sharp spectral line (supposing that such a thing existed). The light waves themselves, going through lenses of finite aperture, form diffraction images of definite width. Most of the width of the observed images arises from this unescapable cause; imperfections in the instrument add but a little.

The width of this "instrumental profile" was measured by photographing a bright-line spectrum containing many sharp lines such as is given by a suitable neon tube (the exposures sometimes running up to as much as five days!), and it was found that an image (in the red) which ought to be perfectly sharp would actually be 0.15 angstrom wide between the parts where the brightness fell to 10 percent of the maximum. Comparing this with the scale of angstroms marked at the top of Figure 2, we see that the strongest lines are considerably wider than this; so that the instrumental shifting of light from one point of the image to another does not disturb the profile to any important extent.

The faint lines are usually (though not always) narrower, and instrumental effects must have a large influence in making the observed curve shallower by filling up the middle with light that by rights ought to go on one side or the other. Though this process makes the observed profile shallower, it also makes it wider. The instrumental imperfections cannot create light, or destroy it—they can only shift it from one point in the spectrum to a near-by one. While stronger light from the sides is diverted into the middle of the line, the weaker light of the line-center is diverted to the sides.

THE net result is that, though the shape of the line-profile may be much changed, its *area*—representing the whole amount of light cut out of the spectrum—is not altered. This area is usually expressed as the "equivalent width" of a perfectly black, sharp-edged line, which cuts out the small amount of energy. For the faintest lines which appear as shallow dips in the curve, the equivalent width is about 0.002 A; for the strongest lines in Figure 2, about 0.2, and for those in Figure 3 rather more than 1 A. For the great H and K lines it is fully 10 A.

With this Atlas, and a planimeter, the intensities of many hundreds of solar lines could be measured far more accurately than they are at present known. One might say thousands of lines, were it not that the lines in the violet, and still more in the ultra-violet, interfere so much that it is practically impossible to draw separate profiles for the constituents of an overlapping group.

Much work on equivalent widths has already been done—some of the best of it by Minnaert himself—and in the preface to the new Atlas, he modestly says that it is "provisional"—meaning that the equivalent widths obtained from it will not be as precise as could be obtained by a careful study of selected individual lines. They are very good, just the same.

To derive from the equivalent widths the numbers of atoms which are at work producing the lines is a major problem, not yet completely solved. The range in equivalent width among solar lines is more than a thousand to one. In the numbers of atoms at work on them the range is much more like a million to one. For the very faint lines, which appear as tiny dips in the curve, the equivalent width is proportional to the effective number of atoms involved. For the strong winged lines, this equivalent width varies as the square root of the number of atoms. For lines of moderate intensity, like the majority of those shown on the graphs, the change of width with number of atoms is much slower. Accurate calculation of the "curve of growth" which exhibits these relations demands a detailed study of the effects produced in successive layers of the Sun's atmosphere, differing in temperature and pressure, and of the possible "interlocking" of lines produced by transitions of atoms of a given element from some particular state, or set of states, to others. There are many fascinating and difficult problems here for theoretical workers. They will rejoice in the new Atlas, even more than the rest of us, for there they will find the material they need to test, and to improve, their theories.—*Princeton University Observatory, January 3, 1941.*

BROWSING with the Editor

IRON AND STEEL—Of the 1,760,000,000 tons of iron and steel which have gone into consumption in the United States since 1854, close to one-third has been repurchased over the years by steel mills and foundries as scrap to be reprocessed into new iron and steel. Of the remaining total, some 1,210,000,000 tons is believed to be still in service in the form of buildings, bridges, automobiles, pipes, bathtubs, and a host of other articles.—*Steel Facts*, December, 1940.

FISH PLANTING—Into the streams and lakes of 34 states and Alaska, the fish planting program of the Forest Service during 1939 placed 288,000,000 fish.—Notes, United States Department of Agriculture.

RAYON—The acetate rayon industry is not quite 20 years old. The last 10 years have witnessed an amazing expansion, first in the field of continuous-filament yarns and more recently in the field of staple fibers. The consumption has increased at a faster yearly rate than that of other types of rayon until today acetate rayon accounts for 30 percent of the total domestic rayon consumption.—*Industrial and Engineering Chemistry*, December, 1940.

TANK PRODUCTION—One hundred eighty six pounds of blue-prints are necessary to detail all the intricate parts of a 20-ton military tank before production can get started.—*Automobile Facts*, November, 1940.

SUPERIOR ASTRONOMY—A 20-inch telescope will now do some types of work superior to that done by the 100-inch telescope of Mt. Wilson Observatory when it was first installed 20 years ago. The improved results are due wholly to the advances made in photographic materials with which the skies are photographed through this telescope.—James G. Baker, Harvard Observatory.

RAIL MILES—There is more railway mileage in the United States than in South America, Asia, Africa, and Australia combined.—Notes, Association of American Railroads.

WILDCATS—About 2500 wildcat oil wells were drilled in 1939. Fewer than one in thirty of these found new oil fields, showing the enormous difficulty and expense in trying to locate petroleum. When the advice of geologists is used in this exploration, about ten times as many of the exploratory projects find oil.—*Oil and Gas Journal*, November 2, 1940.

HORSES AND BUGGIES—In 1939 fewer than 1000 horse-drawn carriages were built, while 4,362,000 automobiles were made. Dr. Vergil D. Reed, assistant director of the Bureau of the Census, compares these figures with those of 1914 when the country's production of carriages, sulkies, and buggies totalled 550,401 and automobile production totalled 543,881.—*Science Service*, November 29, 1940.

CELLULOSE SHEET—Back in 1924 Cellophane cost so much that one small user in Philadelphia locked up his stock in a vault for safe keeping over night. Increased production, increased efficiency in manufacture, and widening markets have lowered the price of the plain transparent film from \$2.65 a pound to 33 cents.—*The Du Pont Magazine*, November, 1940.

RESEARCH PAYS—It is being urged by the National Association of Manufacturers that American industrial organizations as a whole should spend at least 2 percent of their gross incomes for research. Thus would be created a billion-dollar fund to provide new jobs, new industries, new goods. The total expenditure for all basic production research in the United States in 1940 was considerably less than one quarter of this sum—probably in the neighborhood of \$225,000,000.—*News Edition*, American Chemical Society, January 10, 1941.

RATIO OF 15,000 to 1—Prior to settlement by the white man there were 75,000,000 "buffaloes" (bison) in the United States area. Today there are about 5000. No longer, however, is there any danger that the bison will become extinct.—*American Forests*, January 1941, page 12.

LOCUSTS—Once the female locust has laid her eggs, her life mission is done. She flies away and soon dies. In a square yard as many as 50 to 75 separate deposits of eggs are often found, which means that from 5000 to 7500 locusts will emerge from a space 36 inches square. The only effective way of destroying the eggs is by ploughing the ground, for once exposed to the air, the eggs never hatch.—American Wildlife Institute.

RESEARCH REDUCES COSTS—Magnesium, which is vital to our national-defense needs because of its use in the manufacture of airplanes, now costs 30 cents a pound as a result of research. In 1915, magnesium cost five dollars a pound.—*Kodak Magazine*, December, 1940.

STORAGE BATTERY—Few of the products of Thomas A. Edison's genius represent the results of harder work or more prolonged research than does the nickel-iron-alkaline battery which bears his name. Today, this storage battery has a wide variety of uses in industry, including the supply of power to trucks and mine locomotives, and current to airway beacons in remote locations. It is also used for the operation of doors, brakes, signals, traction motors, and emergency lights in subways.—*Inco Magazine*, Volume 17, No. 3.

RHEOLOGY—The word 'rheology' was coined in the United States in 1929 to denote the science of the deformation and flow of matter . . . We study these "phenomena" every time we spread butter over bread with a knife . . . paint a garden shed . . . If it be of any advantage to man to improve bread, butter, cheese, jam, chocolate, inks, paints, varnishes, textiles, building materials, and a host of other everyday commodities . . . then the study of rheology needs no further justification.—*Nature*, London, November 2, 1940.

WILDLIFE CONSERVES FOOD—In the face of nature's prodigality, the creatures of the wild might well be forgiven if they satisfied their pangs of hunger, regardless of wastage. As a whole, however, it has been determined through extensive study that nearly all creatures—whether winged, walking, or creeping—show an instinctive appreciation of nature's bounty. They draw upon it to no greater extent than is necessary for their well-being.—*The Illustrated London News*, December, 1940.

Conveyor System for Planes

Assembly Line Principle Successfully Applied in Airplane Manufacturing Plant

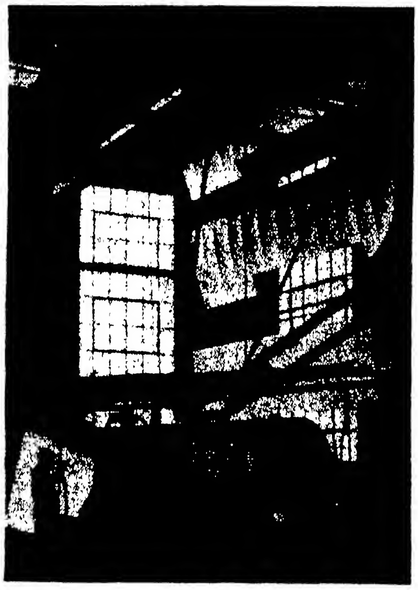
ALEXANDER KLEMIN
Aviation Editor, Scientific American.
In charge, Daniel Guggenheim School of Aeronautics, New York University

It is fashionable to say that, to step up aircraft production, the example of the automobile plants should be utilized fully in building planes and engines. There is every reason to seek maximum help from automobile makers and to farm out everything possible to this industry—engines, bomber parts, or bomber sub-assemblies. In the past, whenever automobile people have tried to revolutionize airplane manufacturing methods, they have met with indifferent success, but now, with necessity driving, the real advances in aircraft production may well come from the aviation manufacturers themselves.

Every day witnesses some new method of speeding up aircraft production. Due to the C. A. A. training program and general increase in private flying, Piper Aircraft Corporation has been flooded with orders and has introduced the conveyor system in

Monorail conveyor system

building its fuselages. Beginning with the priming process, prior to rust-proofing, the fuselage is suspended on a monorail, and cockpit assembly, brake and control assembly, covering doping, sanding and rubbing are all completed while as many as 50 suspended bodies move slowly but steadily forward,



Wing-spraying "Ferris" wheel

hanging from the rail. A somewhat similar system is employed in the wing doping shop. The units are placed on a huge "Ferris" wheel and as they pass on the lower level, workmen spray dope—a nitro-cellulose paint—on the fabric to tighten and strengthen it.

• • •

RESEARCH

Projects Indicate Progress

The Annual Report of the Bureau of Aeronautics of the Navy Department must of necessity be brief and guarded. Normally, the United States is that country which disseminates technical information the most freely. Now that the necessity of national defense and aid to Britain are realized, secrecy must be the watchword of our services, and quite rightly so. Nevertheless, just the titles of some of the research projects carried out under the Bureau's sponsorship are of interest.

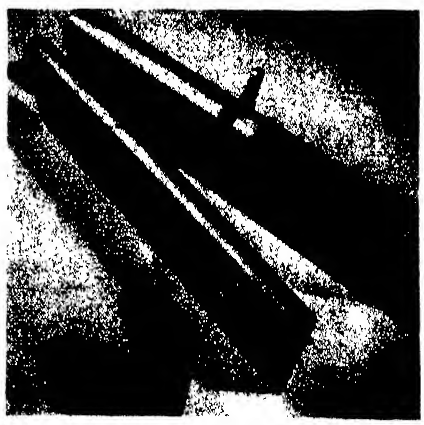
Thus we read of "Properties of Flat Plates under Normal Pressure." The research relates to the strength of a hull, or float bottom, at the instant of alighting on the water. Mathematical calculations are very difficult, and the experimental work now undertaken should make life easier for the designer and stress calculator of the seaplane. As we have had occasion to mention in these columns, plastic construction is assuming importance and the Navy is procuring wings in plastic from a number of firms and will undertake comparative tests.

Flutter of wings is a dangerous phenomenon, and when the test pilot is asked to investigate wing flutter in the air and even to try to induce it, he is undertaking a definite risk. Hence "Dynamic Testing in Flight by Radio Control," the title of this research project, tells the story. Another important undertaking has been in the development of a "Thin Film Rust Preventive Compound." This has been adopted by the Naval Air Service and reports show that it is possible to maintain equipment so protected with an expenditure of less than half the time required when other protective methods are employed. Synthetic silk for parachutes has appeared and proved stronger than real silk; and these constitute but a fraction of the research work completed.—*A. K.*

PLASTIC TABS

Production Possibilities in Small Control Surfaces

Tabs are small control surfaces, placed at the rear of the main control surfaces—ailerons, rudder, or elevator. When the tabs are irreversibly fixed at a certain angle to the main control surface, they cause the latter to hold a certain angular position, up or down as the



Plastic tabs relieve fatigue

case may be, and the airplane is automatically trimmed or put in balance. Tabs are now almost universally employed on large airplanes and relieve the pilots of much of the fatigue of long flights. Hitherto these tabs, just like the main surfaces of the airplane, have been built of aluminum alloy, which necessitates cutting of sheet, folding, riveting, and so on. Now a plastic tab has been developed by the Glenn L. Martin Company. The plastic tab is remarkably smooth and neat in appearance and is lighter and less apt to buckle or wrinkle than the metal tab. Again, it has real production possibilities. The outer skin and the inner longitudinal reinforcement are fabricated in one piece by a single application of heat and pressure.—*A. K.*

STRATOSPHERE

High-Altitude Flying Conditions Produced in Three-Ton Tank

CERTAINLY, the emphasis in aviation today, after many years in which we sought only development, is on quantity production of aircraft, but that does not at all mean that experimentation should cease. On the contrary, experimentation should be pushed more energetically than ever, particularly in special research divisions of our aircraft factories. At least one organization, the Boeing Aircraft Company, subscribes to this principle through the establishment of a stratosphere laboratory in which it is possible to test controls, pressure seals, structural members, and so on, of the supercharged airplane when flown at high altitudes.

High-altitude flying conditions are simulated in Strato-Chamber

The laboratory is in the form of a three-ton steel tank, 12 feet long by 5½ feet in diameter, with pressure-tight doors at each end and divided into two compartments, which are interconnected. One of these compartments represents the cabin of an airplane; the other compartment, the outside atmosphere. Several engineer-observers can be housed in the "cabin" at the same time, and have at their command controls and instruments which duplicate a set outside the tank. Contact with the outside is maintained by means of observation windows and a telephone system.

A motor-driven vacuum pump is used to reduce the air pressure within the high-altitude section of the Strato-Chamber to simulate actual high-altitude flight conditions. Dry ice reduces the temperature of this air to the 30 degrees below zero, Fahrenheit, which may obtain in substratosphere flying. The air is then piped into the cabin and is warmed and supercharged to a condition comfortable to passengers.

With such equipment the engineers can at little expense and in a few hours obtain information that would cost $1000 per hour to acquire in actual flight. If it is desired to undertake physiological experiments on the effect of rarified cold air on the human body, the low pressure from the high-altitude chamber is circulated directly into the other compartment without supercharging. In this case, of course, oxygen equipment may be put into service.—*A. K.*

FIGHTER

Radial Engine Powers Navy's New Ship

THERE is good reason to believe that a chemically cooled in-line engine such as the Rolls-Royce Merlin or the Allison V-twelve gives greater overall aerodynamic efficiency than the radial air-cooled engine, however carefully cowled. But the difference is not very great. And while the 2000-horsepower liquid-cooled engine is still in the development or prediction stage, the immensely powerful radial engines, close to 2000 horsepower, are already available.

The Army Air Corps is emphasizing liquid-cooled engines for its fast pursuits. The Navy Bureau of Aeronautics seems to be a trifle more conservative and to lean to the powerful radials because they are already here. It is not for us to say who is the wiser, but certainly the Navy has reason to be proud of its Vought-Sikorsky Single Seater Shipboard Fighter. The new fighter has passed its tests in magnificent shape, has shown remarkable performance—equal or superior to that of any similar type in the world—and its top speed has been reported as over 400 miles per hour.

1850 horsepower, air cooled

The XF4U-I is a single-place, single-engine, all-metal monoplane embodying all of the most advanced developments of this type of craft. The fuselage is of monocoque construction employing spot welding (which may be an indication of the use of stainless steel) and the finish is therefore exceptionally smooth. The tail surfaces are also of monocoque construction. In front view they present the appearance of an inverted gull wing. This provides low points on either side of the airplane where the landing gear is attached and not only reduces the weight of the landing gear but facilitates towage. The landing gear retracts into the wing, the final closure being made by doors so that when the gear is fully retracted this portion of the wing presents a perfectly smooth surface. The engine is an 18 cylinder Pratt & Whitney double-row, radial, rated at 1850 horsepower or more at an altitude of more than 20,000 feet. The gross weight of the airplane is approximately 9000 pounds, it has an approximate wing span of 40 feet and an approximate overall length of 30 feet. Altogether it is a ship that manufacturers and Navy may both be proud of.—*A. K.*

[Recent advices indicate that Army officials are seriously considering the adoption of a radial type of airplane engine.—*The Editor.*]

Fungi

As the Enemy of Domesticated Plants These Lower Plants Cost us $3000 a Minute

CHARLES M. HACKETT

NOT long ago an itinerant handyman, something of an amateur tree surgeon, sawed a dead limb from a tree. There was nothing unusual in the operation, nor did he note anything peculiar about the rotted wood of the branch. There was no reason why he should have flamed the tool before performing a similar amputation on another tree a hundred miles away. Yet in the following spring when he retraveled his accustomed route, he observed that both trees were dead.

The victims were of the species known variously as sycamore, button-wood, or plane. If the handyman had looked further, he would have seen that these lovely, scaly-barked shade trees were dying by the thousands in the eastern states. They have been afflicted with a blight such as that which has almost obliterated the chestnut tree and decimated the storied elms of New England.

Just what, or who, started this blight, no one can say. It is certain that it has been spread from one tree to another by such incidents as that described here. Sycamores are favorite trees for city street planting, and in many instances entire rows have been stricken, while those across the street remain unaffected. This bears witness, experts say, that the blight may be communicated by pruning tools and saws. The villain of the sycamore tragedy, like that of the chestnut and elm debacles, is a minute parasitic bacterial growth or plant described technically as a fungus. The fungi are not green like the higher plants. They are difficult to find, and are almost incredibly hardy and resourceful. They thrive both in the light and dark, depending on either living or dead animals or plant matter for food. They reproduce rapidly by means of millions of spores or seeds, broadcast by the wind—or spread by animals or man.

In some forms, fungi are beneficial in character. They assist the process of making cheese, beer, and even bread. In their malevolent role, they form the spearhead of a botanical blitzkreig which causes an estimated $1,000,000,000 damage yearly in plant disease alone, with untold further losses levied on lumber and stored materials. Diseases caused by fungi also attack farm animals and sometimes humans.

Millions of dollars are being spent in defense measures. The United States Government's Bureau of Plant Industry has been working diligently for years, seeking answers to many of these problems. State agricultural experiment stations have also done much.

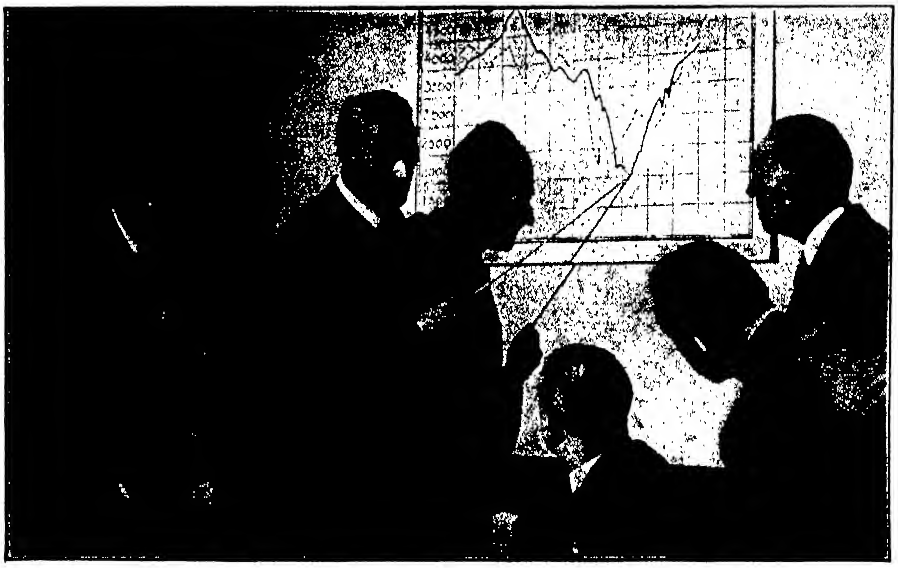
Mold spores from bread. ***Insert:*** **A Du Pont chemist studying the growth of such molds**

More recently, industrial organizations have tackled the fungus menace with all the resources of modern science, and some notable successes have been recorded. The Du Pont Company, for example, maintains a well-equipped pest control laboratory at Wilmington, Delaware, part of which is devoted to research on fungi. This same company also operates laboratories and testing plots for studying seed-borne fungus diseases, and has developed seed-treating chemicals which substantially reduce losses Another Du Pont activity in the field is research in mold, which has produced "inhibitors" to prevent such growths in bread and other materials. Still another deals with the development of "mildew-proofing" preparations.

THE world has been kept well informed of the havoc wrought by insects, since winged or crawling pests are not likely to be overlooked, for they invade our homes and flower gardens, and their descent upon us is vigorous, but the almost-as-deadly fungus works silently and out of sight. Nevertheless, we are faced at every hand with evidences of destruction. There is not a full-grown native chestnut tree left standing on the New England hills which, 40 years ago, were covered with these stately trees. Something introduced the chestnut blight and valuable timber stands were wiped out. The devastation was due to a fungus that became parasitic on this particular tree, then ungratefully murdered its host.

The "Dutch" elm disease is thus far classed as irremediable. Thousands on thousands of these classic American trees, long identified with village square and college campus, have been victims. The fungus of the disease is carried into the wood by a beetle, hiding so completely that treatment by fungicides is considered very difficult if not impossible. Injections, however, are now being attempted, with some promise of success. Spread of the ailment is being checked by inspection, quarantine, and ruthless destruction of all infected trees.

The important white pine industry is being threatened



by a "rust" fungus which alternately attacks gooseberry or black current bushes, then the tree. An active program of cleaning out the berry bushes near pine forests promises solution of this problem by breaking the cycle of the pest's habit.

Most serious salient of the fungus attack is in the field of plant disease.

"A plant," observes Farmer Brown, "hasn't a friend in the world. If the rabbits don't get it, the bugs will. If it's not the bugs, it's the blight. If it's not the blight, it's the wilts."

He might add, there are the rusts, the smuts, the scabs, and the rots, and after them the blotches, the smudges, mildews, galls, and curls. Most of them are the work of the foraging fungi, although some are caused by bacteria and by the viruses. The United States Government figures the toll of these plant diseases at about $3000 a minute.

The Irish cop on the corner may never have heard of fungi, yet they are probably responsible for his being a citizen of New York or of Boston rather than of County Clare or Killarney. It was a fungus disease, potato blight, which brought on the Irish famine of 1845, sending hundreds of thousands of Irish immigrants to the United States. The same fungus is still around, and occasionally gets at the potato crops in this country. Now, however, we have learned to keep it under control with sprays and dusts. In the soil-borne diseases of potatoes, calomel and mercuric oxide have shown promise when mixed with fertilizer. Organic and inorganic mercury compounds are playing a large part in new developments, one important new use being the acid mercury and mercuric oxide dips for potatoes.

NO PLANT is immune to these microscopic marauders. Leaves, flowers, and fruit develop spots, blemishes, and wilts, and may shed off and die. Cankers and galls form on stems, trunks, and roots. Growers have done a great deal with the breeding of disease-resistant species. This is difficult, however, for, as has been indicated, the fungus is a most adaptable campaigner, able to assume a new form through mutation and hybridization. Some of these new forms or strains will attack previously resistant plants and nullify expensive research accomplishments that seemed final.

Rusts of wheat and other grains cause enormous crop losses. One of the worst offenders is "black stem rust," the fungus of which spends a part of its life on the common barberry plant. Large sums are now being spent in the eradication of barberries and the breeding of rust-resistant varieties of wheat. Copper carbonate is an effective dust treatment for controlling "bunt" of wheat, and represents the beginning of a dust method on a large scale.

Dr. W. H. Tisdale, who heads the Du Pont pest control research program, counts fungi among the major problems of America's agricultural economics. A plant pathologist by profession, Dr. Tisdale is one of the nation's outstanding authorities on fungicides. He was formerly associated with the United States Bureau of Plant Industry. Dr. Tisdale is hopeful that the defense forces will prove adequate. "Possibly," he says, "the most significant step in the development of fungicides and insecticides is the focusing of the attention of the research chemist, and the institutions supporting chemical research, on the needs for better pest control.

Spraying fruit with fungicides to control plant disease fungus

"It has not been many years since the plant pathologist and the entomologist selected chemicals as best they could, from the available lists. Now, with the co-operation of the various plant scientists concerned, the statistician, the physicist, and the chemist, we are in a far better position to advance."

Dr. Tisdale points out that the battlefront of fungus warfare is long indeed. Some fungi are carried on the seeds of plants. Others live in the soil, attacking seedlings and the roots of growing plants. Cotton, beans, melons, peas, and flax are subject to wilts and root-rots caused by soil-borne fungi. The flax industry in this country gradually migrated westward until it could go no farther, driven by wilt-infested soil. The fungus root-rot that causes huge losses of cotton and other crops has not yet been brought under control. The costly "blue mold" of tobacco is being checked by fumigation with benzene and paradichlorobenzene.

SEED-CARRIED diseases are being combatted effectively by treatment. Seeds are treated with chemicals developed for the purpose. Large increases in yields have been reported. The "stinking smut" of wheat, for example, which fills and covers the grain with black sooty spores, is held in check by seed-treating chemicals, notably the organic mercury compounds. Many other seed-borne diseases are routed by proper seed disinfectants. The use of ethyl mercury chloride for the treatment of cotton-seed has advanced the control of seed-borne and, to some extent, soil-borne diseases of cotton. It is effective also in curbing seed ailments of flax.

Fungi do not confine their activity to living plants, Dr. Tisdale points out. Raw plant products after harvest are subjected to heavy losses during transit and storage. Foods prepared from plant products are set upon by molds and mildews. "Losses in these products are large," he declares, "despite modern methods of control, including sanitation, refrigeration, heat, and the use of chemicals, ray treatments, and high-frequency currents."

Fiber, hemp, and lumber are subject to stains, molds, and decay. Awnings, ropes and other cellulose fabrics, wallboard, and wood products are attacked. The familiar "blue stain" of freshly sawn lumber brings woe to lumbermen. Chemists have now introduced preparations based on ethyl mercury phosphate to control this discoloration, which is actually the spores of the fungi themselves as they invade the wood.

Oil soluble coppers, such as the naphthenate and oleate, are finding limited use in the treatment of

wood and other cellulose materials, especially fish nets. Phenyl mercury oleate is being used on ropes to prevent decay. The treatment of fabrics, especially cellulosic fabrics, and related materials that are handled extensively or those that contact the human body, is becoming important due to fungus molds. For such needs, water insoluble materials of non-poisonous nature are desired. Salicylanilide has

"Brown patch" on golf courses is one of the fungus diseases

been found suited for such purposes. Special adhesives have been developed that hold the disinfectant in place when the fabric is laundered or exposed to weathering.

The damage to the wooden parts of buildings and other wood products done by fungi is adjudged much greater than that attributable to termites. What the householder calls "rot" is really the remains of a fungus banquet. The spores feed upon the cellulose of the wood. Treated lumber is now curbing a huge national loss from this cause; it also helps to reduce the estimated $80,000,000 annual termite bill.

Although fungus infection among man and animals is less serious than that stemming from their close relatives, the bacteria, some important discoveries are laid to this destructive vegetation. If you've ever suffered from the well-known and highly uncomfortable athlete's foot you've had a taste of it. Ringworm is another sample. Many allergic conditions have been traced to the identical fungi which bring plant diseases.

Even under water, certain fungus families multiply exceedingly and leave havoc in their wake. A fatal fungus invasion is now being combatted among sponges, the threadlike filaments of the fungi having committed appalling submarine mayhem among these useful growths. At one time, the salmon fishing industry was imperiled by a serious fungus epidemic, the fish sustaining heavy casualties.

All fungi cannot be classified as pests. One of the simpler forms of beneficent fungi is yeast, and bread-making would be impossible without it. The distinctive flavor of Roquefort or Camembert cheese arises from fungi employed in the ripening process.

One of the most valuable functions of the fungi, according to Dr. Tisdale, is to serve as scavengers of field and forest, destroying or reducing to elemental form the waste or dead plant products. Fallen leaves, limbs, and trunks of fallen trees and the plant by-products of the farm, when decomposed, return chemical constituents to the soil, again to provide food for growing plants. Carbon dioxide is released to the air during the process of decay, serving its normal and useful purpose in the process of life. Without the fungus action, these waste plant products would accumulate indefinitely, hoarding the valuable plant food elements. We profit by this decay, yet we find it necessary to use millions of pounds of disinfectants on wood products to prevent decay caused by the same fungi.

The gains already chalked up in the battle against these tiny armies are conspicuous. Chemists have found "inhibitors" for checking mold in bread and other products. Sprays and dusts on growing plants provide a defense without which agriculture might well prove inadequate to our demands. Seed treating is an accomplished fact, with scientific studies authenticating its efficiency. Mildew-proofing is now a commercial success.

No one should underestimate the strength or resources of the enemy, and America's scientists do not view their task sanguinely. Nevertheless, as Dr. Tisdale points out, co-operative efforts, enlisting all the skill and knowledge at our disposal, promise results. It's a safe bet that science will win out in the end.

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COTTON SEEDS

De-Linting Process is Money Saver

Down in Missouri some men with an idea are doing things to cottonseed.

These seeds normally have a fine fuzz, or lint, completely enveloping them. They therefore cling together so that when planted they can seldom be dropped singly but

only in clusters of two or more. Later, farm laborers must "chop" cotton—go through the fields after the young plants are up and methodically chop out excess stalks, leaving single ones standing alone. Not only is there a waste of cottonseed but this job of "chopping" is slow and expensive.

These men with the brilliant idea started working in 1923 on a chemical process for de-linting cottonseed and now they have machinery which does the job in rather simple fashion. The fuzzy seeds are fed into a hopper at the lower end of a trough. A worm gear carries them over to another hopper where they are drenched in a stream of sulfuric acid. The acid dissolves off all the lint, leaving slick, black seeds. These seeds are separated by washing the gummy mixture with cold water until all acid is removed.

Besides removing the lint, this treatment permits separation of poor seeds by a process of flotation; bad ones are "floaters."

With planting machinery, these de-linted seeds can be evenly spaced in the row and planted singly, thus eliminating the waste mentioned above plus most of the chopping operations.

ALCOHOL

Sweden Uses More For Motors

SWEDEN is taking steps to expand the output of alcohol employed as motor fuel, according to the American Commercial Attaché, Stockholm. Construction work on a new plant for the manufacture of alcohol from wood using a saccharification process will be started immediately by Korsnas Saw Mills, Inc. Bengtsfors Sulphite Aktb. will construct a new sulfite alcohol plant.—*News Edition,* American Chemical Society.

PAPER COATING

A NEW composition that can be applied to paper in a continuous film makes the paper substantially proof against moisture, odors, and vapors.

The basis of the coating is said to be a granular white material, made by completely reacting chlorine and pure, pale crepe rubber.

For paper coatings, the material is usually mixed with a plasticizer such as dibutyl phthalate, it is re-

ported. Dibutyl phthalate is used because it helps to develop excellent moisture- and vapor-proofness in the finished coating.

BOAT SPEED

Fishline Method For Clocking It

ANYONE who has cast a lead or fished with a sinker knows that the faster the speed of the water in relation to the shore or boat, the greater will be the angle of deflection of the line from the vertical. This is the simple principle which has been used to produce a new type of "log" or speedometer for a sail or motor boat.

This device consists simply of a sinker of special design on a line which is attached to the arm of a scale. As it is held over the side and the speed of the boat increases, the arm on the scale moves toward the horizontal. The scale is etched with numbers up to ten knots, accurately calibrated and tested in the towing tank at Stevens Institute.

Most other modern devices for determining the speed of boats are actuated by the passage of water over a fixed vane in the boat's hull. Unlike these, the new unit, known as the Aquaknot, is portable. To read the speed it is held over the side by hand. In this way its accuracy is not affected by the turbulence which prevails close to the underbody of a moving vessel or by the accumulation of marine growth on the ship's bottom.

Because of its portability, a single Aquaknot may be used to test the speed of any number of different boats. The effect which different sails and their trim have on the speed of a boat can be checked. This is an important item in today's

Lead, line and gage of Aquaknot

Aquaknot tests speed in tank

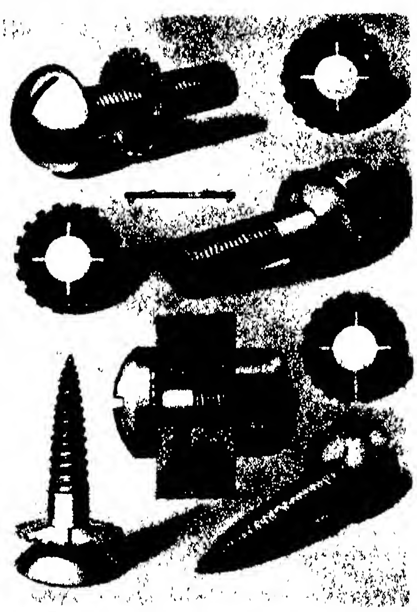
racing which features science and seamanship equally. Accurate knowledge of a boat's speed, besides being a check on performance, is also essential to accurate navigation.

Due to simplicity and sturdy construction, there is little possibility of failure. To resist corrosion and provide the necessary strength, the entire Aquaknot, with the exception of the sinker, is made of Monel by William H. Van Gaasbeck. It was invented by David Moffat Myers.

LOCK WASHER

Positive Locking With Toothed Rim

AN EFFECTIVE, pre-fixed, lock washer, which is designed to be permanently assembled with screws, bolts, or other threaded fasteners, has been developed by Mechanical Laboratories, Inc. These washers are designed for a squeeze fit and are assembled on standard threaded



Uses for pre-fixed lock washer

fasteners when they leave the factory.

This new washer is a disk with a central hole, like that of the ordinary washer. From this hole,

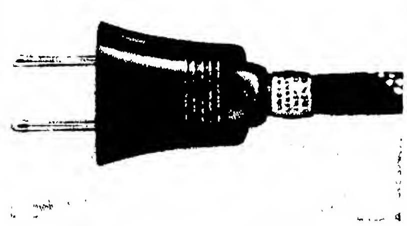
however, slots are cut part way out to the edge radially to provide for the squeeze fit. The rim of the washer is cut with numerous radial slits to provide short tongues. Alternate tongues are turned upward to contact the head of the screw or bolt to provide a toothed grip that prevents the head from turning.

ATTACHMENT PLUG

Holds Tight; Has Anchor Prong

An "ANCHOR" has been built into attachment plugs to promote closer relations between convenience outlets and cords. A new "Anchor Loop" contact prong, with all the virtues the name implies, has been announced by the General Electric construction materials division. It is designed to increase holding power in both old and new convenience outlets without distortion of outlet contacts.

The new prongs can be supplied on several types and sizes of molded-on, all-rubber attachment plugs. The prongs are designed to eliminate excessive stress on outlet contacts, and tests indicate that outlets retain their original ability to hold standard solid prongs after long use of plug caps with new "Anchor Loop" contacts.



Self-anchoring electric plug

DEFICIENCY DISEASE

Chemical Test For Diagnosing Pellagra

A CHEMICAL test for diagnosing pellagra, more specific than any that doctors have had before, may result from a discovery announced by Dr. Victor A. Najjar and Dr. L. Emmett Holt, Jr., of the department of pediatrics, Johns Hopkins University.

Diagnosis of pellagra now is made from the skin rash, inflamed tongue, and other symptoms. A more exact method of diagnosis, such as a chemical test, would be extremely helpful because the symptoms of pellagra are some-

times confused with similar symptoms brought on by lack of other vitamin chemicals than the pellagra-preventive, nicotinic acid. With the aid of the chemical test, doctors could tell whether or not the patient needed treatment with nicotinic acid.

A chemical, as yet unidentified, appears with a bluish fluorescence in alkali-treated excretions of normal persons who have plenty of pellagra-preventing nicotinic acid in their bodies, the Johns Hopkins doctors discovered.

In pellagra patients, this substance does not appear, but another, also unknown, chemical which gives a whitish-blue fluorescence without alkali treatment appears instead.

Disappearance of the bluish fluorescent substance, called F_2, is apparently the earliest change in the kidney excretions in pellagra patients. As the disease progresses, the other substance, called F_1, appears. Treatment of the patient with nicotinic acid, which cures the pellagra, banishes F_1 and allows F_2 to appear again. Both of these substances can be measured quantitatively by the fluophotometer, although the doctors do not yet know what they are.—*Science Service.*

HEAT FROM COLD

First Unit Built

For Homes

The system of heating a house in winter with the same unit that air-conditions and cools it in the summer—which was mentioned in our February issue—has now been adapted for home use. Our February article told how units of this nature extract heat from the cold atmosphere outside an office building and throw off the heat units indoors.

The new air conditioner for the home is the first window type cooler to be developed which also provides heat by reverse-cycle refrigeration. It is designed to fit into an ordinary sized window, has a capacity of 6000 cooling units an hour and a heating capacity of 7500 heating units an hour and up. It comes equipped with an electrical cord which can be plugged into an electrical socket.

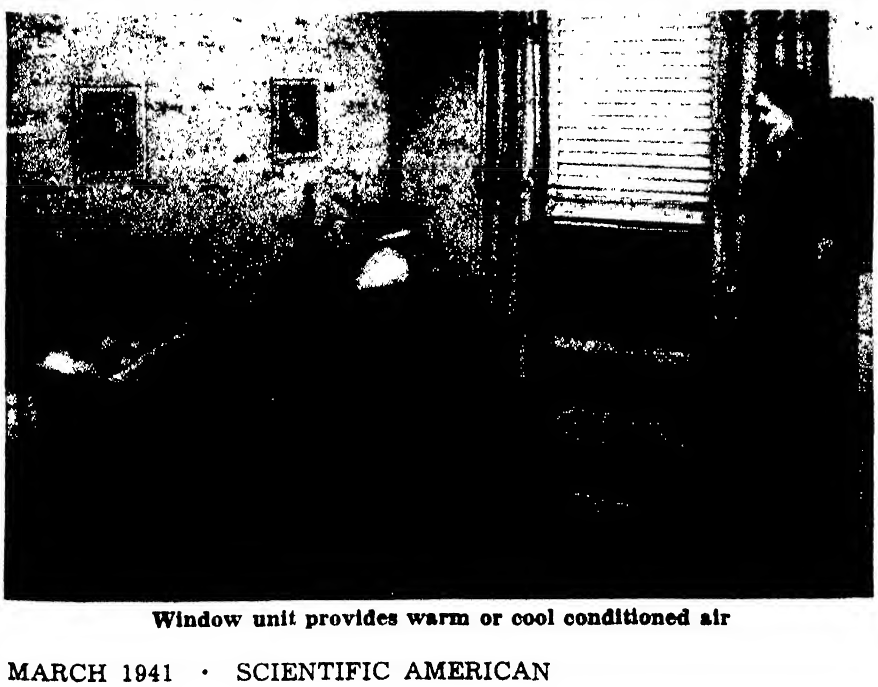
NOT FOOD

Nylon Is, However,

A Protein

Despite bombs and vast destruction in London, the editors of magazines published in that city still seem to have time to do a bit of original—and humorous—thinking along scientific lines. So far as we know, no one in this country has pointed out the fact that nylon is a synthetic protein and that it, therefore, approaches closely to a food made of coal, air, and water. The editors of *Plastics* (London) after discussing the economics of the newer factory-made fibers, have this to say about nylon:

"Which reminds us. Carothers and his remarkable team of co-workers in Du Pont's have produced the first synthetic protein. True, it is not in texture very much like the proteins we encounter in life, except the skins and horn-like proteins, although it does resemble them all chemically. How much



Window unit provides warm or cool conditioned air

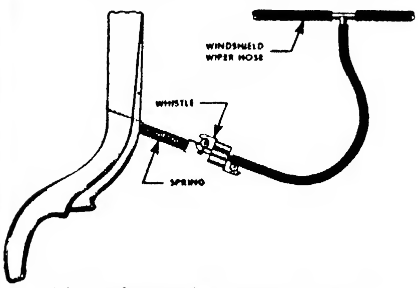
more would we thank Dr. Carothers if he had devoted those years to producing a protein that would be more digestible than his nylon, which is so tough and not readily attacked by the gastric juices. Think of having a dozen chemical factories here turning out tens of thousands of tons of juicy nylon, already treated with dozens of vitamins and doses of the appropriate salts, extruded into just the right size for making sandwiches. And, of course, these factories would turn out not only beef flavour, but ham, lamb, and egg flavours, too! Think of the shipping we would save and how we could laugh at Hitler. This would be totalitarianism with a vengeance."

BRAKE WHISTLE

Notifies the Driver That Brakes Are Set

It is very disconcerting to attempt to start a car rolling when the hand brake is on—while the resultant stalling of the engine sometimes causes dangerous traffic snarls. An interesting accessory for the new Pontiac cars prevents this trouble.

The device consists of a whistle which is connected to the windshield wiper hose and to the hand brake in such a way that when the hand brake is set, the whistle is held open. As soon as the engine is started the whistle blows, thus telling the driver to be sure to release his emergency brake before he starts the car.



It whistles if brake is set

TUNG OIL

Greater Production In the U. S.

More than a million dollars in new wealth will come to the tung growers and millers of the South as a result of the record 1940 crop recently harvested, the U. S. Bureau of Foreign and Domestic Commerce has reported.

In the six southern states now producing tung trees — Florida, Georgia, Alabama, Mississippi, Louisiana, and Texas—the 1940 crop will yield approximately 5,000,000 pounds of oil, despite limits imposed by the damaging cold wave of last spring.

United States imports of tung oil from China in 1939, the established world source of supply for this important commodity, totaled 79,000,000 pounds. Consumption of the oil in this country last year is estimated to be in the neighborhood of 100,000,000 pounds, necessitating the use of reserve stocks. The price of the oil from China has for the past year been approximately 25 cents a pound. Imports of tung oil from China have amounted to as much as 175,000,000 pounds and values have been as high as $20,000,000 a year. The United States, under normal conditions, takes approximately 75 percent of Chinese exports of this commodity. — *News Edition, American Chemical Society.*

"GHOSTLY" BOAT

Hull Made of Clear Plastic

So far we have not been able to learn just why seventeen-year-old Richard W. Boerstler wanted to ride in a "ghostly" boat with all its ribs showing, but he does have such a boat on the Charles River. The covering, according to *Aluminum News-Letter,* is a transparent plastic material which gives the effect of a glass boat. With its aluminum and wood framework and transparent covering, the Boerstler boat weighs only 43 pounds, and is powered by an outboard motor giving a speed of 24 knots.

STIMULANT

Vitamized Hormone Compound for Plant Growth

A new root-growth stimulant, Transplantone, that might well be termed a vitamized hormone powder, has been announced by The American Chemical Paint Company.

Transplantone is a water-soluble powder containing two plant hormones, including napthylacetamide, and three vitamins, including Vitamin B-1 and C. The plant hormones initiate or form roots on established plants, while the vita-

mins help to maintain their continued growth. Transplantone, though in no way to be considered as a fertilizer, is compatible with soluble fertilizer and as such can advantageously be used in starter solutions.

Inevitably, damage occurs to the root systems of plants during transplanting operations, be they tiny tomato seedlings or massive mature trees; and, as a result, the root growth is arrested or definitely retarded. During that period, also, transpiration may be so excessive that the plants wilt or, in severe cases, die. All these deterrents to good growth may be obviated by watering the plants with a solution of Transplantone a day or so before transplanting, or by soaking the roots in the solution for an hour in the case of easy-to-handle plants. A third method involves only the soaking of the soil with the solution after the plant has been set in its new location. The last technique is the method recommended for stimulating growth on all established plants: pot plants, flowers or vegetables, fruit trees, or ornamental shade and evergreen trees.

CIGARETTE CRUMBS

None Drops From Processed Cigarettes

No loose shreds of tobacco will find their way into your mouth, if the end of your cigarette is impregnated with a solution of ethyl cellulose in anhydrous ethyl alcohol, it is claimed by an inventor. The solution, it is said, stiffens and waterproofs the paper at the mouth end of the cigarette, and binds the tobacco shreds together so that they do not become loose.

The inventor also claims that the composition is non-toxic and has absolutely no effect on the taste or odor of the smoke. Best news of all is the claim that absent-mindedly lighting the wrong end produces no ill effects.

UNIQUE GRADING JOB

Highway Bank Graded In Steps

An unusual job of grading the bank of a highway has been done by The Eblen Construction Company out in Iowa. The cut through which this highway runs is 80 feet deep, and in winter it would normally be piled with drifts of snow. Hence, to prevent such drifts, the construction company cut the bank as a series of steep, smooth-sided terraces, using a Caterpillar motor grader.

Similar jobs have been done in the past, but this one offered a particularly bad problem. At the start of the job, the hill was so

Terraces act as snow fences

steep that a detour had to be made in order to get on top with a bull-dozer. Then, after starting the first bench, the motor grader was pulled up the hill by a cable and settled into working position. As the first bench was pushed off with the bull-dozer, the motor grader came along doing the finishing work, and it was gradually stepped down from the first bench to the next one until it reached the bottom of the cut, as shown in the photograph.

TURF DISEASE

Worries Golfers and Greens-Keepers

Golfers, and particularly the greenskeepers of their courses, have something new to worry about: a fungus disease that kills out large patches of the grasses most suitable for putting greens. It was reported on recently by Dr. C. C. Wernham and Dr. R. S. Kirby of Pennsylvania State College.

The two botanists have isolated cultures of the responsible fungus and grown it under laboratory conditions. They find that it thrives most lustily at the high temperatures of midsummer, becoming much less virulent when kept in a cooler place. This checks with the golfers' complaints that their greens are in worse condition in hot weather than in cool.

Field experiments indicate that the disease can be controlled by small applications of dusting sulfur or zinc oxide.—*Science Service.*

CAMERA ANGLES

Conducted by JACOB DESCHIN, A.R.P.S.

Backgrounds For Your Movie Titles

MANY amateur movie fans look upon titles as a nuisance, with the result that either they avoid making them at all or, when they do, try to get the job over as quickly and easily as possible. But a great many more workers feel that if their screenings are to be worth anything at all, titles will help tremendously in making the show complete and professional-looking, as well as adding to the entertainment values of the picture.

Of course, the chore can be accomplished simply by typing on a card and filming the title with one of the many efficient little devices now on the market. However, we feel that titles, too, are part of the film and should be set off in some pictorial way, so that the title is not merely a label, but attractive in itself. Even the cleverest title, when agreeably presented, will prove at least twice as effective if pains are taken to play it up in some way.

One of the methods we would suggest is the use of still shots as backgrounds for the titles. These can be made either at the same time the filming of a particular subject is done, or taken from one's files. The latter method will often be satisfactory, if the scene is general enough to make it suitable in particular instances. However, the best plan is to make a few still shots at the same time you do your movie shooting. The title backgrounds will then be a very definite part of the picture and tie in perfectly with the film.

Cloud pictures offer the greatest opportunity for title backgrounds and, since the dyed-in-the-wool photographer is a sucker for good cloud effects at any time, there must be plenty of these in your files to start a little experimenting in this connection right now. Cloud pictures have the virtue of being general enough in theme to fit into many types of films and, for this reason, plus the utilitarian one that they allow plenty of space for the title, are very useful.

Figure 1 is a sure bet for a movie title, particularly because of the general darkness of the print, which makes it an ideal background for white lettering. Of course, the title should be kept above the horizon line and the legend well spaced to allow for generous borders around the other three sides. This particular print makes an excellent title background for a film of beach scenes. Depending on the subject-matter, it can be used either as the opening or the closing title of the film. If the

Figure 1 (below)
Figure 2 (above)

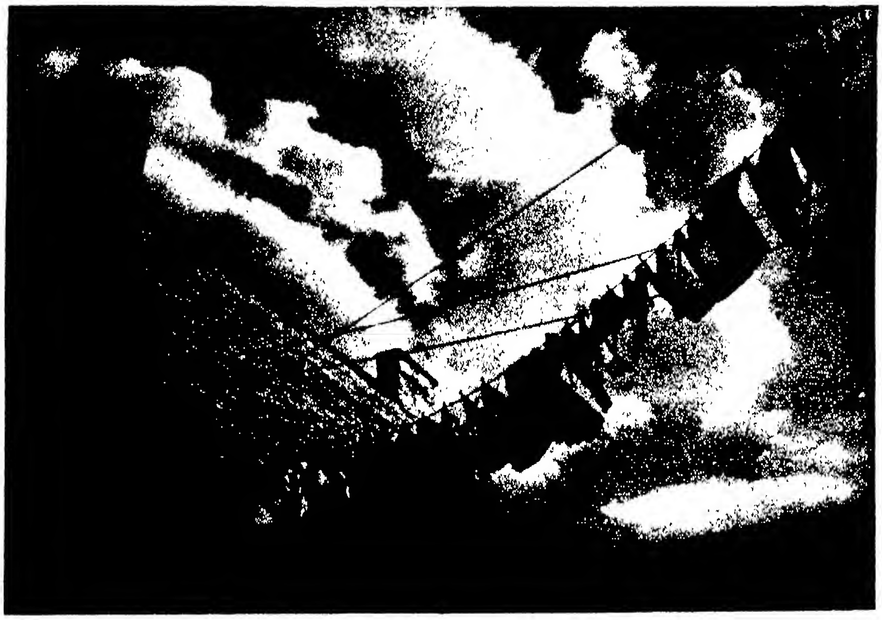


Figure 3 (above)
Figure 4 (below)

story covers that day at the beach last summer, it seems just made for that inevitable "The End" title.

Figure 2 is an idea for waterfront films. Here the lettering can be done so that it reaches higher towards the top than usual. This because there is so much going on in the lower third of the print. A film covering the ever-attractive subject of seagulls flying about the masts of sailboats could use such a title background at almost any suitable place in the film —beginning, end, or somewhere in the middle. In contrast with Figure 1, it suggests movement and atmosphere, and this fits in perfectly with movie technique.

Closer to home and a swell title background for a piece possibly "Wash Day Comes on Monday," is Figure 3. Clouds again, but the clothes-line, roof, and chimneys pack a good story. The obvious place here for the title is the inverted pyramid bounded at the sides by the roof line and the clothes swinging against the sky, with possibly a word or two, preceded by a dash, in the small cloud space below the clothes-line.

Cloud pictures are not the only stills, however, that can be used for title purposes. A story of a street incident in town could well employ such a title background print as Figure 4. The lettering space is again obvious and would, incidentally, balance the content of the print. The dark space seems ideal for a title.

These are merely suggestions that will start a train of thought, the stations at which that train stops determining the types of title backgrounds you will try out for your own movie films.

Rollei Adapter

A NEW, inexpensive, and extremely simple adapter which will permit using Bantam size film with Rollei cameras, has just been announced by Burleigh Brooks, Inc. With this new device, Rollei owners can use the economical Bantam-size Kodachrome roll film, as well as Bantam size black and white film.

The use of this Rollei adapter is extremely simple. A metal masking frame of Bantam size is quickly inserted in the camera back, and a similar mask placed over the ground glass. Two spool adapters, one furnished equipped with a Bantam size spool, are quickly inserted in the spool holders. The complete change from the 2¼ by 2¼ size to Bantam

Bantam size film being loaded in Rollei camera with adapter

size, or vice versa, is merely a matter of seconds. An exposure window, placed in the proper location in the back of the camera, is equipped with green safety material to permit the

Rolleiflex with simple parts needed for Bantam film use

use of all types of film. This film window is absolutely essential in order to insure proper negative spacing. This new Rollei adapter can be installed by your photographic dealer, and the price is extremely reasonable.

Single-Frame Movie Work

SOME of the many possibilities available to the movie camera sporting a single-frame movie device, by which a single frame may be exposed at a time, as in regular still photography, and then projected in the usual way, are cited by Bell & Howell in connection with the Filmo 141.

"A map can be animated with a line which extends as by magic to trace your travel route," they suggest. "Letters in a jumbled mass, or even grains of sand, can arrange themselves, on your screen, into a neatly composed title. Dolls and toys can be made to move on a miniature stage as though alive. Clouds can be caused to billow past trees or mountain tops with accelerated, clearly visible motion. Explanatory diagrams may be animated. And, if you can draw a little, you can produce animated cartoon films, like Mickey Mouse . . . even in color!"

Snow as Color Subject

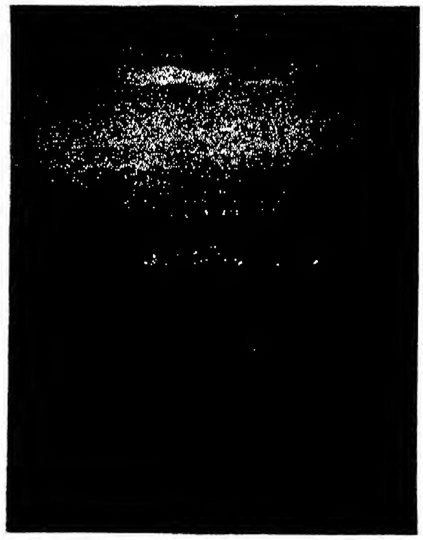
WHY shoot snow in color since it is all white? Actually, snow is an excellent subject for color photography because, although to the casual glance it may appear to be paper white, it contains delicate color hues that can be picked up and revealed in a well-exposed color transparency. This is due to the fact that snow is a fine reflector of the colors of the objects around it. These include trees, houses, people's clothing, and so on, plus, of course, the blue of the sky.

Lighting For Scientific Movies

HENRY M. LESTER, noted for his motion picture work in scientific and surgical fields, employs an arrangement whereby two miniature spotlights, one on each side of the stand supporting his camera, provide the illumination. These lights are mounted on adjustable supports, obviously a great necessity in his type of work. Mr. Lester uses the F-R Hi-Spot, alternatively employing one Hi-Spot in conjunction with a GE R2 reflector flood lamp, the latter combination when photographing an eye operation. His movie camera is the Cine Kodak Special. Mr. Lester finds the combination of spot and flood highly useful, but adds that "it does not lend itself to high-low circuit arrangement, which circuit, however, is fully applicable to two Hi-Spots operating at the same time."

Foreground Shadows

WHEN the foreground is empty and therefore without interest, a shadow will help to fill up the expanse, as in the accompanying illustration. It fills the space by providing a pattern, which, being dark, does not call too much attention to itself and therefore permits the eye to center attention on the main subject. Such a large area as that shown in "Provincetown Pattern" does, however, usually require some shadow detail in the pattern to show through. Smaller areas can do with jet-black shadows, if necessary.



"Provincetown Pattern"

Acid-Proofing Sinks

FOR that darkroom sink or table, here is a formula that has worked well in at least one laboratory:

Solution No. 1

125 grams copper sulfate
125 grams potassium chlorate
1000 grams water

Solution No. 2

150 grams fresh anilin oil
180 grams concentrated hydrochloric acid
1000 grams water

After cleaning the surfaces free from dirt and paint or varnish, if any, apply two coats of No. 1, using a paint brush and applying hot. Follow the usual procedure of allowing each coat to dry before applying the next

and then apply two coats of No. 2 in the same way. When completely dry, wash with hot soapsuds and finish with raw linseed oil, rubbing the oil well down to obtain a polish. As the table or sink is used the polish will wear off somewhat, but an application of linseed oil will freshen it up again.

Amidol Developer Hint

REFERRING to our little piece in the March 1940, issue, on amidol development, Alfred L. Fitch, of North Easton, Massachusetts, says that the information agrees with his experience in over 20 years use of it, but that he found objectionable the necessity for weighing the formula each time it is used.

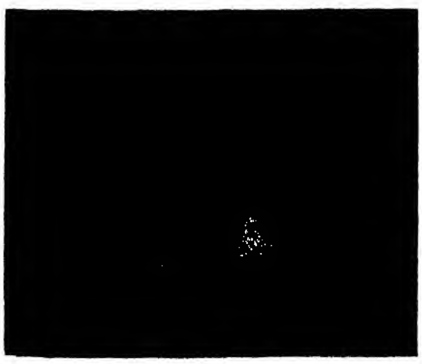
"For a number of years," he writes, "I used a three-solution pyro developer for plates and kept solutions of pyro, carbonate, and sulfite which were mixed at time of use. The sulfite was 60 degrees by hydrometer, of which I took 1 oz., a level mustard-spoonful (10 gr.) of amidol, and 4 ozs. of water, to which was added 10 to 20 drops of 10 percent bromide of potassium solution. This I found more convenient than weighing each time. Multiples of these quantities were used according to the size and number of prints to be made."

Body Heat as Intensifier

ALTHOUGH not to be recommended as a general practice, some darkroom workers have found that rubbing the palm of the hand against a highlight that seems tardy in showing up detail, will help to speed up development in the local spot and thereby print out the wanted highlight detail. The reason for this, of course, is the basic one that the higher the temperature of the developer the quicker the development; the palm of the hand soaked in developer and warming the latter by friction provides the increase in temperature.

Stunting With a Kaleidoscope

THE kaleidoscope is a tube with a peep-hole at one end and a sort of pill-box containing an assortment of colored pieces of glass at the other. Two mirrors or pieces of glass blackened on the back are set at an angle to each other inside the tube. The



Kaleidoscope portrait

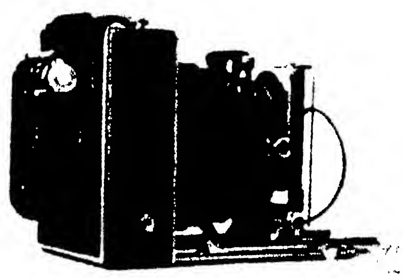
device is pointed towards a light and,— as the front element is revolved, various symmetrical designs are formed. The kaleidoscope may be used in photography to obtain multiple effects, as in the accompanying illustration. Both back and front elements are removed and one end attached in front of the lens. The tube is turned to obtain various arrangements. Exposure, to hold the extra images, is approximately four times normal.

Bantam Back for Film Pack Cameras

REDUCING backs for view cameras or the popular ground-glass focusing type of film-pack cameras are not new. The introduction of Kodak's new direct positive panchromatic safety film in 8-exposure Bantam size rolls, however, has revived interest in a special back to handle this film.

Such a back can be easily constructed from two plate-holders of a film-pack camera, but the ground-glass focusing panel supplied with the camera cannot be used.

The center portion of one plate-holder is cut out and matched to the exact size of the opening in the plastic case of a Bantam f/6.3 Kodak. The all-in-one piece, lens-shutter-bellows assembly, attached at the factory to the camera by four screws, is not used, but the screw holes are used to attach the plastic case to the plate-holder of your camera, as shown.

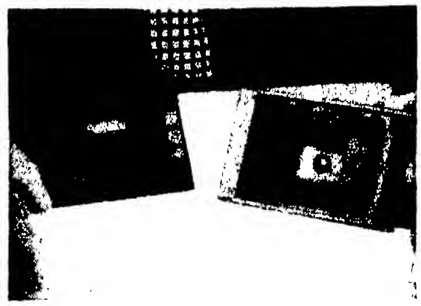


Home-made Bantam film back for pack camera is simple to make

To make the assembly light-tight, press in some Plastic Wood between the Bantam case and the plate holder after the screws have been tightened. The dark slide of the plate holder operates as usual and will only be removed from the loaded Bantam case during an exposure and then replaced.

The second plate-holder, with a small center section removed, is made into a focusing screen by mounting a small piece of ground glass on a cut-out block of wood, the same distance from the front surface of the plate-holder as is the film plane of the Bantam equipped holder. The screen is encased in a small metal can or other form of focusing hood as shown in one of the pictures.

To register the images, place a piece of ground glass on the film runway of the Bantam holder and focus a test object sharply by racking the lens in the usual manner; then carefully lock this point. Remove the Bantam holder, replace it with the second holder containing the cut-out block of wood and ground glass, and adjust this ground-glass back and forth until the previously focused image comes up needle-sharp. Make this adjustment permanent on the focusing holder and the job is finished.



Focusing and film-holding backs

The obvious and varied uses to which the device can be put need no discussion here. The Bantam camera case complete, but *minus* the lens-shutter-bellows assembly, can be obtained on order from Kodak through your dealer.—*Herbert E. Hayden.*

Police Restrictions

WITH war abroad and fifth column talk in this country, life for the amateur photographer is no longer the carefree business it has been. In New York City, after a number of incidents in which persons were stopped when attempting to take snapshots from bridges and similar places, the police department was queried on the subject. Police Commissioner Lewis J. Valentine, although assuring amateurs that they will receive every consideration and not be interfered with by the local police, advised amateur photographers to use discretion "in the taking of photographs at or in government reservations, such as the New York Navy Yard and army posts, transatlantic steamers, important public utilities and so on."

Composing on the Easel

COMPOSITION of subject-matter should be done directly in the ground-glass or finder, they tell us, but this is not always possible. Sometimes, too, projection of the negative on the easel gives us other ideas on how to treat the particular subject. Compositions are made of lines, masses, and light contrasts. The exact result cannot always be studied properly while observing the subject on the easel. Here is an aid that may spell the difference between a good and a bad composition or at least between a good composition and a better one. Place a sheet of ordinary white paper or cardboard on the easel and mask it as usual. With a pencil, draw out-

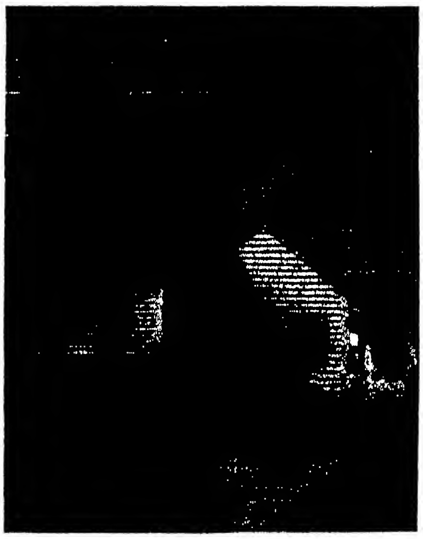
lines of the principal lines, masses, and darks and lights, shading heavily for the shadows (the light tones on the easel), and lightly for the highlights (the dark tones on the easel). Then study the result by white light. This will give you a pretty good idea of how the subject is composed.

Copying Texture Subjects

THE routine copying technique is to illuminate the original with one light on each side directed at an angle of 45 degrees to the plane of the easel on which the original is mounted. However, there are instances, as in the case of textiles, where it is desirable to show the texture of the surface as well. This is accomplished in a simple manner. Instead of having both lamps equidistant from the easel, place one of the lamps at the usual 45-degree angle, but move the second one in a distance equal to two thirds of the other. This technique will give a good copy and at the same time show up the surface of the original.

Human Interest

TO MANY workers a landscape is incomplete unless it contains some suggestion of a figure. No matter how small the figure, it brings the landscape or some such study as "Country Home" to life for them. The boy running towards the house fills the bill in the present case, even though he is somewhat indistinct due to movement.



"Country Home"

Shooting Friends

TOM WEBB, New York illustrator, is a photographer by avocation, and for the past three years has taken a particular delight in shooting his famous friends when they come to call on him. His portraits have been placed in such high esteem that he has had two one-man shows in two years. Frank Crowninshield, editor, says of the portraits that they "mirror a man's inner life rather than the transitory and superficial aspects of his physical exterior."

Kyohei Inukai, by Tom Webb

"Cameras like Tom Webb's," he adds, "can be bought anywhere. Concerning his films, too, his darkroom, his developer, his technical methods, there is no mystery at all. The enigma, all of it, springs from Tom Webb himself; his sensitiveness as a man, his ability to apprehend and evoke; to imbue his sitters with an added and, perhaps, unsuspected aura."

Mr. Crowninshield himself is among Mr. Webb's "victims," as are also Kyohei Inukai, the portrait painter, Mr. Webb's study of whom is reproduced here; Bruce Barton; Pierre Van Paassen; Dean Cornwell; Owen Davis; James Montgomery Flagg; John Golden; Rube Goldberg; Clarence Buddington Kelland; Grantland Rice; and many others.

Utilizing Rubber-Cement Waste

THE penny-saved-is-a-penny-earned philosophy is put to practical use by the students of an art school, who save the excess cement along the sides of a paste-up and roll it up into a ball which is used as an eraser. They find it wonderfully efficient in erasing spots and dirt, particularly in wiping up the leavings of a removed strip of scotch tape. The trick will work as well for photographers.

Why Pure Water for Solutions?

THE frequently occurring question concerning the use of pure water in mixing developer solutions is discussed authoritatively by LeRoy Rose-lieve, an xpert in these matters and designer of the fine grain developer X-33, in a recent issue of *The Foto Review*, a publication o. Fink-Roselieve Co., Inc.

"The fact is too often forgotten," he writes, "that water demands most serious attention when mixing and diluting developers, fixing solu-

tions and other photographic formulas. Few are aware that even municipally supplied water may cause an endless amount of trouble from a photo-chemical standpoint, due to the fact that it may contain a large amount of harmful impurities. These impurities occur in the form of various calcium, aluminum, copper, and iron salts, in addition to minute vegetable and marine matter, which react with the chemicals used in solutions and are very harmful in their chemical reaction during processing.

"Iron salts appear particularly in considerably large quantities since the water has to pass through a multitude of metal pipes made of various alloys of questionable condition. During its journey through these pipes the water will collect and carry a lot of iron deposit and other impurities. The presence of any considerable quantity of iron salts in a developer will seriously affect the photographic emulsion and the chemical action of the solution itself. Developers mixed in water of doubtful purity break down rapidly and produce an abundance of stains, black spots, and other blemishes on the surface of photographic emulsions.

"Therefore, we cannot stress too greatly the importance of using only purified and preferably filtered water for mixing solutions if no distilled water is readily available. This precaution will eliminate the possibility of contaminating solutions with impurities which act as oxidizing agents in a developer, thus decreasing the life and usefulness of solutions. The slight expense involved in using distilled water or equipping water faucets with filters will more than pay for itself by insuring a longer life to developers and fixing solutions besides producing better results in negatives and prints."

Why Home-Made Safelights Fail

Although the amateur worker with a yen for making his own gadgets may do so with many odds and ends of small equipment, safelights are not one of the things he should attempt. The ordinary means is to use a red bulb or screen the lamp with a piece of green cellophane. But this is inadequate and far from safe when handling sensitized materials. In this case, at least, it is better to purchase the commercial product, for the reason that, it being difficult to obtain a single simple dye that is pure in color, the commercial slide is made up of a number of different colors. The red bulb, on the other hand, while it may look red, may also be transmitting some blue, and this blue will fog the emulsion.

Daylight Shots Indoors

Sunlight through curtains, a bowl of peaches on the kitchen table by the window and patterns of light nicely arranged make up the ingredients of "Still Life." A snapshot ex-

Simplicity is the keynote of still-life camera studies, many of which can be shot indoors by daylight, as was this example

posure with a reflex camera held in the hand while standing on a kitchen ladder to get a down-tilt, caught this picture at 1/25th of a second, f/5.6, on fast pan film. Opportunities such as this are frequent in the home. Sometimes the arrangement is just as you want it; sometimes the table is cluttered up too much; a picture is possible only if one object, such as the fruit bowl here, is isolated from the rest. If sufficient depth is not possible with a snapshot, move farther away and enlarge only the wanted portion, or, of course, use a tripod.

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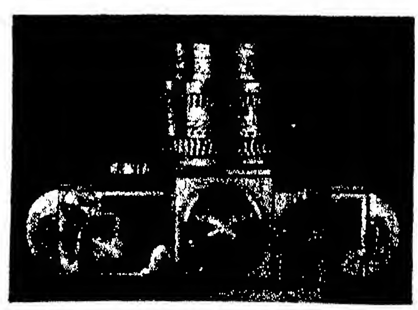
WHAT'S NEW

In Photographic Equipment

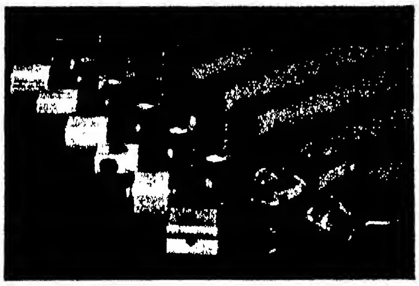
Kodak Ektra ($235 to $325): Eastman's new high-grade 35mm miniature camera, featuring interchangeable backs, comprises three units: camera body, interchangeable



Operating controls of new Kodak Ektra are grouped on top

lens, interchangeable magazine back. Body and back, when placed together, combine into single trim unit, with rounded ends fitting user's hands. Each back has manually set exposure-count dial, mechanism for moving film, visual indicator to check on film movement, metal slide which automatically covers film opening as back

is unlocked from camera body. Sliding lock keeps back fully light-tight when unloaded from camera body. Back cover also has small metal indicator dial to identify film in magazine. Film winding by small lever takes



Interchangeable magazine backs are one feature of new Ektra

two quick flicks of thumb. Interchangeable lenses include Ektar *f*/3.5, 35mm focal length; Ektar *f*/1.9, 50mm focal length; Ektar *f*/3.5, 50mm focal length; Ektar *f*/3.5, 90mm focal length; Ektar *f*/3.8, 135mm focal length; Ektar *f*/4.5, 153mm focal length. All lenses, surface-treated to improve clarity and brilliance, couple automatically with Ektra range finder. Focusing by range finder to five feet on two telephoto lenses; to 3½ feet on others, with closer focusing by scale. Diaphragm scale, distance scale, direct-reading depth-of-field scale engraved in large numerals on lens; special indicator for infra-red film. Lenses screw in; positive lock holds them in position. Large, milled ring for rapid preliminary focusing, with smaller milled focusing wheel for final adjustments. Shutter of preselected type, width of slit established as shutter dial is set. Shutter speeds above 1/25 second (up to 1000) selected by lift-and-set dial; slower speeds (1 second to 1/10) by auxiliary dial. Brown cowhide combination case ($15) available to take camera with lens, extra magazine back, two extra film cartons, several filters. Ektra may be purchased with any desired lens, including telephoto.

KINGDON FILM WASHER ($1): For washing film in Bakelite or metal reels. Handles up to dozen 4 by 5-inch cut films or three rolls 35mm film. Eight outlets in base for expelling hypo-laden water. Washer incorporates own elevated base. Rust-proof spun-aluminum construction.

CRAWFORD FLEXICHROME PROCESS ($6 complete outfit): For making inexpensive color prints from black and white negatives, by contact or enlargement on special Flexichrome Matt Base Positive Relief Film. Process produces black dyed gelatine relief image on white backed celluloid base, colors being applied to surface with brush. Outfit includes set of 12 Flexichrome colors (in one-ounce bottles); Flexichrome Modeling Agent or Black Dye Bath (powder) to make 64 ounces, or 2000cc working solution; Flexichrome Liquid Paper Backing (6½-ounce jar); Flexilene Quick Drying Cover Varnish (four-ounce bottle); chromic acid; ammonium bichromate; soft flat backing brush; camel's hair paint brush; Flexichrome lintless paper-napkin blotters (200); instruction booklet. Flexichrome film available separately in sizes 5 by 7 to 20 by 24 inches, prices varying $1.05 for half-dozen 5 by 7 to $30 for dozen 20 by 24.

BOES MODEL A 35mm FILM WINDER ($4.50): For daylight loading of bulk film into all standard magazines and cassettes. Capacity to 100-foot rolls of Eastman film or 50-foot rolls of other popular brands. Bulk film storage chamber normally closed when spool leaders are threaded. Film gate opened when door is closed. Film emulsion does not touch winder at any point. Special inter-lock feature prevents opening door unless film gate is closed. Frames counted automatically.

KODAK PRINT LACQUER (60 cents for 8-ounce can): Designed to protect surface of prints from marks, dust, abrasion, and atmospheric discoloration. May also be applied on album covers, leather surfaces of cameras and cases, other equipment made of natural or artificial leather, and metal parts (to prevent oxidation and discoloration).

SEECLEAR FOTOFOLIO ($5 for deluxe genuine leather; $3.50 for imitation leather): For filing contact prints. Equipped with transparent acetate pockets for inserting prints. Each pocket attached by cloth hinges. Each pocket holds two prints back to back with negatives between. Pockets flip back for display.

SIX-20 FLASH BROWNIE ($4.25): Features built-in shutter synchronization for Photoflash. Takes pictures 2¼ by 3¼ inches. Accessory flash-holder $1.50 extra; may be purchased separately. Similar to Six-20 Brownie Special, but two threaded electrical connectors provided on front of case to take flash unit and carry synchronizer current. Flash holder made of black molded material, with four-inch polished metal reflector. Socket of spring type. After firing, bulb is released by finger pressure on two small projecting clips, and shake of camera.

ENLARG-O-METER ($4.95, including Reco Gray-Scaler): Exposure meter for enlarging timing, featuring micro-star providing sharp division between matching surfaces, making readings possible as low as 1/50 foot-candle over area 1/16-inch diameter; automatic switch turns unit off when not in use; simple cam shutter instead of rheostat; two-color dial for easier settings; Bakelite case. Reco Gray-Scaler supplied with meter makes calibrated gray scale with relative exposure number printed right on strip.

YOUR FIREARMS and FISHING TACKLE

Conducted by A. D. RATHBONE, IV

INTEREST IN FIREARMS *is traditional with American men; fishing tackle is a requisite of one of the world's oldest occupations. Scientific development of guns and tackle, in the use of which millions yearly find sport and recreation, fathers this monthly department which welcomes correspondence from readers.*

Marlin—1941

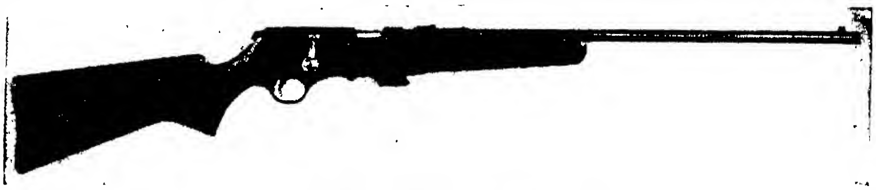
When you receive your copy of the Marlin Firearms Company's new 1941 catalog, you'll have an encyclopedia of the entire Marlin line of 35 splendid guns. You'll find 10 rifles in the .22 caliber class, eight in the .30-30 group (which includes your option of a .32 Special Model), 15 over/under shotgun models, and two smart numbers in the .22 smoothbores with which to break miniature clay targets. Model 101-DL bolt action, single shot, .22 caliber, is going to delight the nation's junior target shooters, for it is self-cocking, has peep-sight, ramp front sight and hood, swivels, and a 24-inch round barrel —all for slightly over seven dollars. This should help produce a good crop of younger generation gunners, a healthy sign in this country these days.

Another new Marlin for folks who like to smash little clay targets with .22-caliber scatter shot is Model 80-CSB, a smooth-bore, 8-shot, clip type, bolt-action repeater whose 24-inch round barrel is recess-choked to aid in scattering the tiny pellets. Other .22-caliber Marlins are two single-shot bolt actions; two 25-shot bolt action, tubular magazine, 24-inch, round barrel guns, one equipped with peep-sight, ramp front sight with hood, and swivels. Then, there's Model A-1C, an automatic .22 rifle, six-shot clip type, for long-rifle cartridges only; and its brother, with peep-sight, hooded ramp front sight, and swivels. And, of course, the old reliable Marlin 39-A (May and November 1940), one of the country's finest small-caliber rifles since its inception in 1891.

In the heavier caliber group—.30-30 or .32 Special—you'll find eight excellent guns, of which Model 36A-DL, with 24-inch barrel, 2/3 magazine, six shots, checkered grip and forearm, detachable swivels, leather sling strap, and pistol-grip cap is the newest member. In .30-30 or .32 Special, this is Marlin's latest contribution to the deer-hunter's happiness, and, although not available until late June, it will sell for less money than other guns in the same field.

Marlin's series of Model 90 over/under shotguns needs no introduction to American shooters. This year they'll be featured with checkered grip and forearm, whether of double or single (non-selective) trigger style. They may be had in 26-, 28-, or 30-inch barrels in the 12 gage; in 26- or 28-inch barrels in the 16 and 20 gage; in the .410 bore, with 26-inch barrels, all with the double trigger. The same selection is offered in the single-trigger gun except that the .410 is not made in this style. The single trigger is *absolutely* positive in action and *will not* fire both barrels. Due to war-time conditions, it has been necessary to suspend manufacture of the famous Skeetking.

Another Marlin 1941 feature is the new style buttstock, best described in the words of the catalog: "Marlin introduces a new and one-piece military type buttstock, handsome with fluted comb and semi-beavertail forearm, for its popular .22-caliber rifles. Fashioned for easy holding, balance, and 'feel,' the new buttstocks have the fine proportions usually associated with custom-made firearms."



One of Marlin's newest guns

All details of these and other guns are completely listed and illustrated in the new Marlin catalog. If you'd like one, just let us know, but please —*please*—remember to send us six cents in stamps to cover mailing and other costs.

Want a Tackle Tax?

The so-called Pittman-Robertson Act provides for annual Congressional appropriations to many states from the 11-percent federal excise tax on sales of sporting arms and ammunition. Any state which receives approval of its rehabilitation projects for its wildlife participates in the annual grant of these accumulated funds, provided the state (1) appropriates 25 percent of the cost of such projects and (2) goes on record legislatively not to divert

hunting license funds and fees from conservation channels. During the last two years this method has provided close to $6,500,000 for wildlife restoration projects, other than fish, in the states that have participated.

Now comes another piece of legislation, known as the Buck Bill, modeled on the Pittman-Robertson Act, and reportedly designed to accomplish the same thing for fish that the P.-R. Act has done for wildlife. However, the situation does not appear to be comparable. Questionnaires were sent to several state conservation departments asking whether they needed or would be interested in federal funds for rehabilitation of fish.

Three of the states that are among the hardest fished in the country—Indiana, Michigan, and Wisconsin—advised that additional funds were not needed. Anglers in California are reported to be definitely opposed. In our opinion, this is a poor time to consider another tax on the sportsmen. We're going to pay increased taxes to support the national-defense program, and certainly, until the states themselves are more unanimous in their desire for federal help, we see no reason to over-burden the already burdened sportsman with an extra 10-percent tax.

Angling Heresy

When a man occupies himself for two to three months every year for five years in diligent, assiduous angling for Newfoundland Atlantic salmon, and when he then says, "No spring will ever be complete without a day of salmon fishing," he has proved fallacious the old adage, "Familiarity breeds contempt." To the contrary, Lee Wulff, angler of many waters, author, artist, and motion-picture photographer of rod and line sequences that cotton your mouth, tingle your spine, and make you want to go and do likewise, maintains the salmon is deserving of more respect than any other game fish.

The salmon fisherman, says Wulff, faces the dual task of acquiring a technique different from that he has used in other forms of angling, and of mastering sufficient ichthyological lore of *Salmo salar* to enable him to fish intelligently and with even a moderate amount of success. These tenets are particularly true in view of the gradual but decided change in salmon tackle. The long, two-handed rods are disappearing from the Humber, the La Poile, the Gander, the Codroy, and other famous Newfoundland streams. In their places are found five- to six-ounce rods from 8½ to 9½ feet long.

An advocate of lighter rods and terminal tackle, Wulff suits his equipment to stream size and conditions, often using a two- to three-ounce rod to accomplish what he considers the peak of salmon fishing sport—to hook, play, and land a big fish, unaided, on light tackle. Terming his own method of playing a fish "rank heresy," he explains that after the fish strikes and starts the run, he lowers the rod to an almost horizontal position, thus permitting the line to flow freely through the guides with a minimum of friction. The instant the run stops or slows up, the rod is flipped back to vertical to provide the necessary line tension to hold the fish, and slack line is then reeled in. The process is repeated until the salmon has become sufficiently tired to land.

As to leaders, length and thickness depend on water and weather conditions, but Lee warns us to "use light leaders to catch more fish," and suggests leader lengths from six to 25 feet, "each having its proper place under the varying conditions of the fishing." He says, "the length of the leader is equally as important as its thickness in fooling the wary fish." His leaders taper from .022 down to .012 or .011 for normal angling, but he has successfully used tippets as fine as .008.

Wulff and 15-pound salmon

Heretical or not, Lee Wulff's fishing methods and his study of the salmon bring him results with a maximum of sport. To acquire his extensive knowledge of where salmon lie in streams, what they prefer in lures, and why; how best to hook, play, and land them, he catches—and returns—an average of 500 fish per season. If the fish are properly played, brought in quickly before they are too tired, and if a gaff or other injurious instrument is not used in landing, 99 percent of fish so landed will live.

Admittedly, an angler who so exhaustively studies his avocation is in a position to discuss the sport with authority. This Lee Wulff has done in his latest book on salmon, "Leaping Silver," which is profusely illustrated with his own drawings and photographs. Of exceeding interest to clubs and organizations that desire to provide entertainment for mem-

bers, are Wulff's "Newfoundland Series" of motion pictures in full, natural color. These graphically depict not only salmon and trout fishing in Newfoundland, but also deep sea angling off the coast, as well as hunting trips for ptarmigan, caribou, and moose. Lee's latest folders are available to clubs and other groups.

"Those Mossbergs"

When, last May, we told you about the new .22-caliber rifles by O. F. Mossberg & Sons, Inc.—Models 42M, 46M, and 51M—we received so many inquiries we couldn't go fishing. We suspect that situation will re-occur—except we'll have to give up ice fishing, not stream angling—when we tell you of certain refinements that will be found on all Mossberg guns in 1941, and particularly on Model 51M, which is the 15-shot automatic that handles .22 regular or high-speed long-rifle cartridges, either lubricated or dry, and which proved so universally popular last year.

Mossberg's model 51M

Every 1941 Mossberg gun will have a blued finish that will be second to none. The Mannlicher, Mauser, or Military type—whichever name you prefer—exemplified by these three models was so acceptable to shooters that no change is contemplated in general design and styling. Each member of this "M-Family," you'll recall (May 1940), is equipped with hooded ramp front sight with four permanently attached inserts: No. 2 rear sight with screw adjustment for windage and elevation; No. 4 micro-click peep-sight which swings out of the way, permitting use of open or 'scope sights. All have detachable swivels, non-breakable molded trigger guard with finger grooves, and in the cases of Models 42M and 46M, there's a Mauser-type bolt-action that hugs the stock and doesn't interfere with 'scope mountings.

In Model 51M—the automatic—the shooting world will be treated to two more Mossberg innovations. The safety, which was formerly a red and green "traffic light" type on top of the small-of-the stock, and just behind and below the rear end of the barrel, has been changed and improved. It is now in the form of a lug-bolt, positively operating from the receiver port, and by means of which the action of the gun may be backed up and held open at the port for cleaning purposes without removing the bolt containing firing pin and the balance of the firing mechanism. If, however, it is desirable to extract the bolt and firing section of the receiver, this can be easily and simply done by sliding the whole apparatus from the rear of the barrel without use of any tools. All parts are so constructed that it is impossible to reassemble them *incorrectly*. They're made to fit and fit perfectly; one way, and one way only—a boon to many shooters.

The four inserts of the hooded ramp front sight are composed of a wide, flat-top post; a narrow, flat-top post; a bead; an aperture. They are permanently attached to the gun in a notch in the ramp, can't be lost or bent out of shape when not in use, and, depending on the type of shooting and the gunner's preference, are quickly swung up into place or folded down into the notch, out of sight and harm.

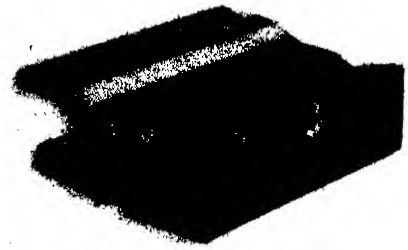
The three "M" guns are drilled and tapped for all Mossberg side-mounting telescope sights. The 1941 catalog is now on the press and will be ready by the time you read this. In it, you'll find all we've said, and more, amplified by pictures and descriptions. We'll be glad to send you a copy, if you'd care to have one.

• • •

POT-SHOTS

At Things New

Outing Manufacturing Company, makers of tackle boxes galore, show real appreciation of value of non-corrosive metal to ocean-going anglers by offering the world's only Monel metal tackle box in generous proportions—21-inch length, 6½-inch width, and 7-inch height. It boasts two automatic cantilever type trays with six compartments in the upper,



Monel metal tackle box

nine in the lower, ample room in the bottom for reel, large plugs and complete supply of tackle. Coated with clear lacquer inside, in black, ripple-finish baked enamel outside, Outing's newest comodious tackle box is waterproof, weatherproof, offers a life-time of service.

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MUST WE GROW OLD?

By Barclay Newman

UNIVERSAL is the realization that we all must grow old—unless in the meantime science finds ways to head off this slowly creeping process. This makes the subject of the present book equally universal in appeal. And scientists *are* at work on research connected with numerous angles of this all-important problem. What they are doing is explained in this work in seven lengthy, topical chapters. One discusses geriatrics, our newest medical specialty which deals with the diseases of old age, now that an increasing proportion of the population reaches advanced years. Another asks whether death need invariably be the result of some precipitation cause, as at present; that is, without such cause would we live on and on indefinitely? A third deals with food factors which limit life, and a fourth with our hormones, chemical messengers of the blood, which may number our days. Cancer and the problem of aging is a fifth, and a sixth is high blood pressure. The author, primarily a scientific man (biologist), writes for the reader who wants scientific substance to his reading, not just fluff; and, while this still is a popular work, it is a solid one based on recorded research in biological literature. (269 pages, 5½ by 8 inches, unillustrated.)—$2.60 postpaid.—*A. G. I.*

MEN AND VOLTS

The Story of General Electric
By John Winthrop Hammond

IT IS curious that a history of one of the outstanding industrial and research organizations of the present day should end with the year 1922. Since the material for the present book was finally brought into shape, 18 years have elapsed, during which there has indeed been remarkable progress in the electric industry. On the other hand, the progress from the beginning of the industry in the United States up to the year 1922 encompassed the romantic period of rapid and unparalleled development. In these pages is told the story of the struggles with early dynamos, the sales resistance that had to be overcome before electrical power and distribution could be started even on a small scale, the early days of the electric light, the battle between the arc and the incandescent, and all the other ramifications of the early struggles of electricity. While the text is essentially devoted to those organizations which eventually were merged into the now famous General Electric Company, it deals also to some extent with contemporary work in allied industries. A brief epilogue and an appendix to the original author's text serves quickly to bring the reader up to date. (436 pages, 6 by 9 inches, a large number of illustrations.)—$2.60 postpaid.—*A. P. P.*

LEAPING SILVER

By Lee Wulff

AN Alaskan by birth, an ichthyologist and an expert angler by dint of exhaustive research in many waters, the author has followed his two other successful books, "Lee Wulff's Handbook of Fresh Water Fishing" and "Let's Go Fishing," with this splendid dissertation on salmon angling in Newfoundland. For the experienced salmon fisherman, as well as for the would-be *Salmo salar* nimrod, this book is packed with informative helpful data "On the Life of the Salmon," "On Where Salmon Lie," "On Salmon Tackle," "On Hooking the Salmon," "On Playing the Salmon," all simply and informally told. For the sportsman who collects beautiful books, there is a Limited Edition of 540 autographed copies in half leather, in slip case, with full color frontispiece. (150 pages, 6 by 8 inches, 72 action photographs, 26 sketches.)—Regular edition, $3.60 postpaid; Limited edition, $15.10 postpaid.—*A. D. R., IV.*

MULTIPLE HUMAN BIRTHS

By Horatio Hackett Newman, Professor of Zoology

UNTIL this book was written there was no book on this subject for the general public. Professor Newman, an outstanding American scientist, has made the study of twins and the science back of them a specialty for 25 years. This most readable book deals with the mutual intimacy and interdependence of twins; odd notions entertained about them; one-

The Editors Recommend

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WHO WALK ALONE

By Perry Burgess

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FM

An Introduction to Frequency Modulation

By John F. Rider

ALTHOUGH this compact book is designed for the radio service-man, it will give the intelligent layman an excellent insight into the operation of frequency-modulation transmitters and receivers. In final analysis it deals with those things which it is necessary to know in order properly to service FM receivers. (136 pages, 5 by 8 inches, a large number of drawings.)—$1.10 postpaid—*A. P. P.*

U. S. CAMERA ANNUAL 1941

Edited by T. J. Maloney

Prints selected by Edward Steichen

PUBLISHED for the first time as a boxed set of two volumes, this Annual, now in its fifth year, offers in the first volume a pictorialization of the American scene, and in the second a portrayal of the best photography of the year as selected by Edward Steichen, dean of American photographers. Particularly delightful is the piece, "Horton, Kansas, a Midland Chronicle," by J. W. McManigal, widely famed for his farm pictures. Helpful because of the detailed instructions and clarity of style is Eliot Elisofon's compact article-manual on "Flash Photography," supplemented by many illustrations.

—OUR BOOK CORNER—

Carl Mydans writes of his experiences in covering the Finnish war, and Pare Lorentz evaluates the work of Dorothea Lange. A biographical article by Hartley Howe on William Henry Jackson, 97-year-old photographer of the old West, is a valuable contribution. The photographs, both in color and black and white, cover a wide range of effort by professional and amateur and, in general, are indicative of an increasing sense of values among American photographers. (Two volumes, 248, 256 pages, 9 by 12 inches, many photographs)—$5.35 postpaid.—*J. D.*

A BOY GROWS UP

By Harry C. McKown and Marion LeBron

If your adolescent boy never causes you any headaches, this book probably won't help you or him, but if he is a normal adolescent and therefore occasionally seems to need steering, it may provide some useful ideas for directing his energies and giving him some sound outlets and attitudes. Typical chapters: Fitting into the Family Picture and into Organizations; Studying Your Own Progress; Skills and Hobbies; Jobs. (299 pages, 5¼ by 8 inches, illustrated.)—$2.10 postpaid.—*A. G. I.*

HOW TO KEEP MENTALLY FIT

By Lowell Thomas

Mr. Thomas explains that the brain is simply a muscle which, like the biceps, needs constant exercise. Elaborating upon this theme, he shows how quick-witted men in the public eye maintain their sparkle and command situations because they never permit brain laziness. Then he gives a large number of what are commonly called brain-teasers, a number of general quizzes, games with words, and information tests. This reviewer can vouch for the amount of mental exercise required on the brain teasers alone. (248 pages, 5¼ by 7¾ inches, illustrated.)—$2.10 postpaid.—*F. D. M.*

SCIENCE IN PROGRESS

Edited by George A. Baitsell

Ten Sigma Xi lectures given at Yale: Stadler on the experimental alteration of heredity; Went on the regulation of plant growth; Fulton on experimental studies of the functions of the frontal lobes in monkeys, chimpanzees, man; Johnson on the mysterious craters of the Carolina coast; Lane on how the earth shows its age; Robertson on the expanding universe; Anderson on cosmic rays; MacInnes on motions of ions and protons in electric fields; Beans on the ultracentrifuge; Hunsaker on recent advances in aeronautics. All are a notch or two stiffer than ordinary popular writing. (317 pages, 6 by 9¼ inches, 129 illustrations.)—$4.10 postpaid.—*A. G. I.*

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

It's just a commonplace that the fellow who can always have whatever he wants by writing a check for it doesn't get as much fun out of what he owns as the other fellow who has to exercise his resourcefulness as well as his muscles in order to possess the same thing. The rich man will be the first to agree with this.

Rev. C. J. Renner, Trenton, Ohio (population 636), has managed without much actual cash expenditure to accumulate two good telescopes plus a serviceable observatory, and the letter he writes sounds as if he had had a great deal of fun in doing it. The two telescopes (Figure 1), one an 8" reflector, the other an 11", are built largely from spare parts—an iron wagon tire for a base, cast-iron drain pipe for a pedestal, steering knuckle for a polar axis, half of a rear axle housing for another. Such parts come ready made and in good proportion for adaptation to the needs of a telescope mounting.

The larger telescope has a tube skeletonized to obviate stray air currents that sometimes circulate within conventional tubes to the detriment of good seeing. Simply, ovals are cut out of it. This telescope has a flat instead of a prism for diagonal mirror and Rev. Renner says he found making it a most interesting job though it took a long time. He was permitted to machine the mounting at the Miami University shops, where he was helped through the woods by Prof. Wm. Albaugh, himself interested in telescope making. Leo J. Scanlon, of Pittsburgh, lent patterns for the castings.

Figure 1: **Renner's pair**

"One great thrill," Rev. Renner writes, "was to build the little observatory. [Not yet finished when Figure 2 was taken.—*Ed.*]. Its total cost was less than $15, because it is made mostly of parts from the junk yards. I used water pump pulleys from Model A Fords for rollers under the revolving dome and the sheet metal was second hand, though the shutters are of new metal." He adds casually that, while doing all this, he also has been making household furniture and helping build a parish house. Maybe country parsons have more fun than city ones.

Tragedy? Not altogether. Suppose you had put in the spare time of two months grinding and polishing the concave mirror for a reflecting telescope, and then accidentally dropped it on a concrete floor, knocking the long slice off its edge that shows in Figure 3. That's what happened to Eugene R. Jolly, 3523 Fourth Ave., Los Angeles, California. Yet no great harm was done to the actual optical performance. Jolly made a new mirror, which incidentally required only 10½ hours because the experience already gained enabled him to go straight ahead with the second job without running up blind alleys. Only then did he discover that the remains of the first mirror performed as well as the second one. There is no theoretical reason why a mirror or lens must be round. The base of Jolly's telescope mounting (Figure 4) is cast integral with the two uprights forming the polar axes. The two setting circles are 16" lids obtained from the American Can Co. and laid off to appropriate angles.

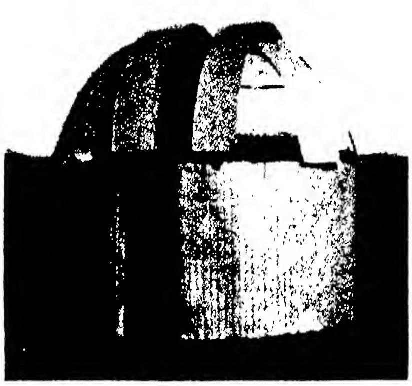

Figure 2: **The observatory**

The electric drive is equipped with a variable speed motor, Model V-10R, made by the Bodine Electric Co., Chicago, and the gears are from the Boston Gear Works. A three-way remote control switch permits the operator, while at the eyepiece, to run the drive at speed, or at approximately sidereal rate, or to stop it. Jolly states that experience in building this drive proves that there is no substitute for a good motor with plenty of power, which will save headaches later on.

He also comments on the fortunate fact that among amateur telescope makers there are as many ideas for telescope design as there are amateurs. He found telescope making fun, also that it taught lessons in patience and perseverance. He winds up: "I know of no greater thrill than the first night performance, when all the trials and tribulations of building were repaid a thousand fold by the first glimpse of the moons of Jupiter, the rings of Saturn and the Great Nebula in Orion."

How many who have made telescope mirrors can say that the work greatly increased their tenacity as applied to other things? In this sense it rates as a real character builder.

Suppose the glass tool is broken? One amateur says his tool broke squarely in two during coarse grinding and he glued it together, later used it as the base for his polishing lap, and got a fine figure on his mirror without trouble from this source. Another tells how he practically destroyed the tool by accident; it broke into about eight pieces. Yet, when cemented to the plate with pitch, it worked all right. Before doing the cementing he took pains to bevel the sharp edges, otherwise chips would have broken off and caused bad scratches.

Of course, if the tool should break after all grinding was done, and during polishing, a lap could be made on any other rigid substance which will not warp (as would happen if wood were used, for example). Russell Porter, when a beginner, broke one and remade the lap on an old stove lid, and this dodge worked satisfactorily.

Ramification of amateur telescoptics is spectroscope making and spectroscopy, either for astronomical or laboratory use. Unfortunately, this ground never has been organized more than sketchily for amateur purposes—that is, there is no convenient amateur's manual of spectroscope making and spectroscopy. The exist-

Figure 3: **The broken mirror**

ing literature is scattered, fragmentary and mostly takes for granted that the reader already is a physicist and knows much about the subject. For years about one request for such a manual has reached the editors each month. A little preliminary skirmishing revealed the probabilty that amateur spectroscopy, except possibly in a limited way, is largely a contradiction in terms, because spectroscopy so

Figure 4: Jolly's drive

quickly leads into the advanced physics that underlies it. In fact, on this account some assert that it simply cannot be made elementary or easy.

Now, in order to pay its own way in the world, any book must be assured of a sale of several thousand copies, not merely the one or two hundred copies such as the limited number of advanced amateurs undoubtedly would absorb. Is the desired book on amateur spectroscopy then not possible?

The solar spectroscope is relatively simple; there is an abundance of light from our nearest star. For a few other bright stars you also can rather *play* with a small spectroscope attached to a 4" or 6" telescope, but, in order to do much with the other stars, you need a considerably larger light gatherer. To the amateur this leaves only laboratory work in spectroscopy, using artificial light sources. On this the articles on the spectroscope and spectroscopy, in Glazebrooks "Dictionary of Applied Physics," are helpful but not elementary. W. E. Forsythe's "Measurement of Radiant Energy" contains 33 pages on the adjustment of spectroscopes but, being aimed at the physicist, takes for granted a general familiarity with spectroscopes and spectroscopy. S. Judd Lewis's "Spectroscopy in Science and Industry" is an excellent little book. The *Journal of Applied Physics*, Nov., 1939, contains a bibliography on spectrochemical analysis, and the American Society for Testing Materials, Philadelphia, also has published such

a bibliography. Yet none of these is really elementary, Lewis's book, named above, being the most so. The "Proceedings of the Optical Convention of 1926, Part II," shows the construction, but not actual instructions for the construction, of a rather elaborate goniometric spectroscope.

In short, the amateur who exploits spectroscope making will have to be resourceful in filling in the big gaps between existing pieces of literature, themselves hard of access.

There still are, however, quite a few amateurs who already know

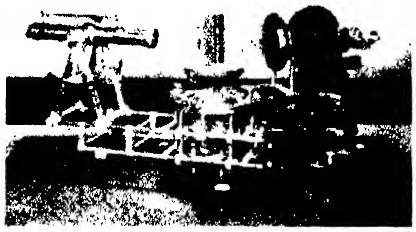

Figure 5: **Trumbull's neat job**

something of the general background of spectroscopy and spectroscopes and who might make their own instruments. For example, Austin F. Trumbull, Airline Liaison, Aeronautical Radio, Inc., National Press Bldg., Washington, D. C., has built the instrument shown in Figure 5. "I never fail to read the section of Scientific American on telescoptics," he writes, "although my interest in optics does not center primarily around the telescope. I built this spectroscope for less than $50, around two old surveying instruments, one for the collimator and one for the telescope, which I bought for $10 each. One came from the Union Pacific and one from the City of Cheyenne and, from my inquiries, I gather that there are hundreds of these old 'transits' throughout the country. A base plate, the two transits, a good prism and a bilateral slit, and you can start to assemble. The only real problem is the slit, which is difficult to make. [See "ATM," pages 247-8.—*Ed.*] This particular assembly is not suitable for celestial work."

Asked to describe the instrument in detail, Trumbull begged off for one year because of absorbing preoccupation with a certain task of that length. Who among the readers can jimmy this subject open for the *average* amateur?

SITTING down instead of standing up is the really luxurious way to make mirrors. On the night in June, 1925, when your scribe first visited Stellafane to gather the material to write a story which started this hobby off among our readers, he showed Russell Porter a sketch of a sitting down grinding rig, the mirror to be rotated by the feet. Porter said this wouldn't be sportsmanslike; you must do it the hardest way (sacred New England tradition, no doubt). Not yet having made any mirror, and feeling humble, your scribe subsided and did it standing up.

Now comes Robert E. Smith, D.D.S., Medico-Dental Building, Sacramento, California, with the creation shown in Figure 6. He says: "Being a dentist, I am on my feet much of the time and, after a long trek around the barrel at night, grinding a mirror, my doggies sure do howl. Hence," he continues, "the machine that allows me to sit.

"The turntable lifts off, and the removable galvanized pan catches all overflow. The motor and worm gear on the concrete-filled tub base were taken from the slow motion of my first telescope. Fins were put on the motor shaft to slow it down. There are two gear reductions, 10 and 20 r.p.m., and a flexible shaft goes to the worm gear shown. The latter carries a pulley, and the belt gives the spindle, inside the pedestal, one revolution per 100 seconds, which may perhaps not be orthodox, but it worked splendidly [is OK, and no exact speed is orthodox.—*Ed.*].

"The spindle runs on ball bearings top and bottom. The turntable is removable (slot and key), facilitating quick, complete clean-up after each size of abrasive used, simply by removing and cleansing the annular pan."

Note the Doctor's stool, with its patent adjustment and soft cushion, plus a spiral spring near the bottom.

Figure 6: **Smith's solid comfort**

What sybaritic luxury! Being lazy, your scribe always wanted one of these but is also too lazy to build it, so what?

HINDLE grinding machines of the alligator type, described in the fourth edition of "Amateur Telescope Making," have made good; there are numbers of them in use. The one in Figure 7 was made by Alfred Bryant, 516 Eggleston Ave., Kalamazoo, Mich., who confesses he built it at first mainly to watch its wheels go

round, since he felt that "making a mirror by hand puts the personality of the worker into the mirror." Later he "'fell for" this machine for mirror making.

He secured his speed reduction from an old washing machine, as he also did the alligator drive—it had been a wringer post drive. The take-off that drove the revolving cylinder of the washing machine, when reduced to half speed, worked out well for the

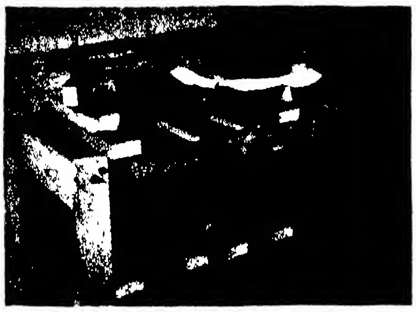

Figure 7: **Bryant's machine**

side-throw motion. Result was 28 r.p.m. on the drive part, 6 r.p.m. on the side throw and 1½ r.p.m. on the turntable. There is, of course, no cast-iron law about these speeds; many write to inquire for the "rule." The rule is, simply, use common sense. Don't give it so much speed that it performs like a speeded-up motion picture doing a crazy act but, instead, as calmly deliberate as a good hand worker moves.

Bryant had made eight mirrors by hand, so he started the machine on a 12½" Pyrex disk. He found he still had a few new things to learn, but says the machine seemed uncanny with its variations of stroke. Grinding in all stages went like a top, and so did polishing. The machine even brought the mirror, an *f*/6.6, to a paraboloid "by first intention," as Ellison says. "Really," Bryant writes, "it is a wonderful machine and does things impossible to do by hand. The way the mirror rotates in the opposite direction to the table, due to the loose rubber bumpers, is a corker, and it merely floats on top, just as Hindle states."

Bryant's log for the *f*/6.6 12½" Pyrex mirror runs as follows:

Carbo No.	Wets	Hours	Strokes
80		6	9000
150	28	4	6750
220	22	3 2/3	6160
400	22	2	3360
500	16	1 1/3	2240
600	16	1 2/3	2680
Emery	10	1	1680
Totals		19 2/3	31840
Polishing		38	63840
Grand total		57 2/3	95680

THOSE who saved the Walkden discussion on matching RFT eyepieces and objectives, in the November number, are requested to place a vinculum over both the 2.5 and the *a*', in the second column of page 300, near the middle: Square root of the two.

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

OPTICS AND WHEELS is a 32-page, thoroughly illustrated booklet that shows how scientific knowledge of optics and light have been applied to solve the problems of night automobile driving. It tells the whole story from kerosene to modern "sealed beam" headlights. *General Motors Corporation, Detroit, Michigan.—Gratis.*

THE OBSERVER'S HANDBOOK FOR 1941 contains data on the planets and other astronomical phenomena, month by month; also lists of double and multiple stars, variables, four star maps, an ephemeris of the Sun, and miscellaneous astronomical data to the extent of 80 very useful, practical pages. Most amateur astronomers obtain this booklet each year. *Royal Astronomical Society of Canada, 198 College Street, Toronto, Ontario, Canada.—25 cents.*

WHAT IT TAKES is a 32-page, completely illustrated booklet designed to present in simple terms the fundamental factors of time, planning, and specialization that are necessary for the creation of today's unparalleled values through mass production. Text and illustrations pertain specifically to the automobile industry, an outstanding example of mass-production possibilities. *Automobile Manufacturers Association, New Center Building, Detroit, Michigan.—Gratis.*

ENGINEERING STANDARDS AND TECHNICAL INFORMATION is a 16-page, illustrated booklet that gives specific data regarding "Aero-Thread" screws, studs, bolts, and nuts. "Aero-Thread" is a screw-thread system in which a spring wire insert is employed between the tapped hole and the mating screw. *Aircraft Screw Products Company, Inc., 25-12 Forty-first Avenue, Long Island City, New York.—Gratis.*

THE STORY OF MODERN INDUSTRIAL WEIGHING is a large illustrated folder that shows a wide range of weighing equipment specifically designed for certain industrial uses. A series of photographs shows these devices in use; a comprehensive group of illustrations shows specific forms of equipment, accompanied by compact data. *The Exact Weight Scale Company, Columbus, Ohio.—Gratis.*

PHOTRIX UNIVERSAL PHOTOMETER is a new 8-page folder that deals particularly with the use of the photometer for measuring the density of negatives and with the evaluation of these density measurements for determining exposure time in contact printing and enlarging as well as for balancing three-color separation negatives. Other chapters deal with the use of the photometer in testing the efficiency of various types and makes of enlargers, for studying the effect of the lens opening upon the light distribution, and so on. *Intercontinental Marketing Corporation, 8 West 40th Street, New York, New York.—Gratis.*

IT'S A NEW BUSINESS CUSTOM is a completely illustrated booklet that tells the story of tough manufacturing problems solved with the use of Durez plastics. Reports such as this can be highly inspirational to industry in general. *Durez Plastics & Chemicals, Inc., North Tonawanda, New York.—Gratis.*

KOPPERS CHEMICALS FROM COAL is a 28-page pocket-size booklet devoted to a description of some of the materials which are obtained from coal. Physical and chemical properties are listed for each and some suggested uses are included. *Koppers Company, Koppers Building, Pittsburgh, Pennsylvania.—Gratis.*

THE MICO ENGRAVER is an 8-page catalog which describes and illustrates a versatile pantograph machine adaptable to many lettering tasks associated with experimental work as well as with the routine production of panels, name-plates, and small parts. *Mico Instrument Company, 10 Arrow Street, Cambridge, Massachusetts.—Gratis.*

MICROMAX TEMPERATURE INSTRUMENTS FOR ELECTRIC POWER EQUIPMENT is a 32-page, illustrated catalog for those concerned with the operation of generators, frequency changers, large motors, transformers, and cable systems. Micromax recorders prevent loss in industrial plants by providing automatic and continual temperature checks on a wide variety of jobs. *Leeds & Northrup Company, 4934 Stenton Avenue, Philadelphia, Pennsylvania.—Gratis.*

PORTABLE ELECTRIC TOOLS is a new 60-page catalog which fully illustrates a complete line of 132 portable electric tools. These range from a variety of power hand drills through hammers, saws, power shears, sanders, and so on, to industrial vacuum cleaners and a complete line of accessories. *Black and Decker, Towson, Maryland.—Gratis.*

BAKELITE MOLDING PLASTICS is a 32-page, illustrated booklet which contains descriptions of molding processes and explains the differences between thermosetting and thermoplastic materials. The physical, mechanical, and electrical properties of phenolics, ureas, polystyrenes, and acetates are enumerated. Request booklet on your business letterhead. *Bakelite Corporation, 30 East 42nd Street, New York City.—Gratis.*

Printed in the U. S. A. Press of the Wilson H. Lee Company, Orange, Connecticut

TO all those who claim supernatural powers—whether they be spiritistic mediums, table tippers, or whatnot—Scientific American offers an opportunity to prove their claims. In a search for the truth regarding psychic phenomena in general, there is offered through this magazine a total of $15,000, under the rules laid down on page 210 of this issue.

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SCIENTIFIC AMERICAN

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NINETY-SEVENTH YEAR • **ORSON D. MUNN, Editor**

APRIL • 1941

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50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of April, 1891)

PROTECTION—"No man objects to paying money to have his house insured against fire, though he never expects it to be burned, nor should he object to the slight tax necessary to insure his house, his business, his country, against the transgressions or the possible transgressions of an enemy. . . There is no greater temptation to malevolents than an undefended people; a country with unprotected shores is an invitation to all the thieves and robbers of the world."

BATTLESHIPS—"The unnamed battleships, Nos. 1 and 2, are now in course of construction at the Cramp shipyard in Philadelphia. The contract calls for their completion by Nov. 30, 1893. . . These vessels are to be built of steel; to have a double bottom for the distance of 196 feet, extending the length covered by the machinery and magazine spaces; all the vital portions to be amply protected; every feature being provided to enable them to cope successfully with vessels of the heaviest armor and armament. The forward and after turrets for the 13 inch guns mark the extremities of obstructions upon the main deck. . . Between the turrets for the 13 inch guns there is a superstructure in which are placed the 6 inch guns; and above, or upon the deck erected thereon, are placed the 8 inch guns. A battery of 6 pounders is arranged along the top of the hammock berthing and bridge, and 1 pounders are placed forward and aft on the berth deck. The double-topped military mast is cone shaped, placed on top of the conning tower just abaft of the forward 13 inch gun turret, two 1 pounders being placed in the lower and two Gatling guns in the upper top."

BEST MECHANICS—" 'Americans are the best mechanics in the world.' This assertion was recently made by an English scientific journal of high authority, and so true it was that it has remained uncontradicted. Indeed, European journals abound with descriptions of American accomplishment in the domain of applied science, and the detail of American practice and American criteria prevail to a very important extent in European workshops."

NATURE'S HINTS—"One hundred years ago Galvani published a description of certain phenomena, which were the first indicators of the mode of energy now known as electricity. And a century hence, when our successors look back on our work of to-day, what will most engage their attention is not the great industrial achievements of which we boast, but the conscientious following out of some mysterious hints of nature, as mysterious as were the twitchings of the frog's legs suspended from an iron balcony in Bologna in the year 1787."

CAVALRY—"Too much cavalry, so it is claimed, is a serious defect of the German war establishment. . . 'Cavalry armed with sword and lance, like the uhlan,' says a general of divison, writing on the subject, 'is more likely to encumber an army than to advantage it.'. . . He believes it to be the province of cavalry to reconnoiter and force an unestimated enemy to show his strength, and would have wagons carrying infantry to storm fortified places during aggressive reconnoitering."

SMOKE ABATEMENT—"Something over a year ago the municipal authorities of Chicago began to move in dead earnest against the owners of steam-making plants, manufacturers, railroads, hotels, etc., for their constant violations of the ordinance which declared the emission of volumes of black smoke from chimneys, smoke stacks, etc., to be a nuisance. . . The result has been that the nuisance has been to a large extent abated. This has been accomplished very largely by the use of devices which force jets of air in sufficient quantities into the furnace to secure complete combustion. This method has proved satisfactory on both locomotives and stationary engines, and has helped largely to clear the atmosphere of Chicago from the black smoke which soft coal produces."

NAVAL BUILDING—"As many years are now required as months formerly to build and arm a modern battleship. What folly, therefore, to talk of creating a navy in an emergency. If we are to have a navy at all, let us have one that can whip the enemy if we must fight, and one that will be a school of the highest form of mechanical education if we shall be blessed with peace. The country's naval strength cannot be reached and maintained by impetuous and spasmodic effort; it can only result from a well determined programme of such magnitude and duration as will induce our manufacturers to make the requisite provision for such a supply as will secure and reward their best efforts."

POPULATION—"If the United States had a density of population equal to that of Rhode Island, the population of the Union, instead of being 62,622,250, would reach the enormous sum of 945,766,300, or nearly two-thirds of the present population of the world."

FROM AN ADVERTISEMENT—"The American Bell Telephone Co. 95 Milk St., Boston, Mass. This Company owns the Letters Patent granted to Alexander Graham Bell, March 7th, 1876, No. 174,465, and January 30th, 1877, No. 186,787. The transmission of Speech by all known forms of Electric Speaking Telephones infringes the right secured to this Company by the above patents, and renders each individual user of telephones not furnished by it or its licensees responsible for such unlawful use, and all the consequences thereof, and liable to suit therefore."


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WHAT ABOUT ALUMINUM?

CHARGES of monopoly, of purposely restricted production, of hindering the defense program of the United States, have been leveled against the Aluminum Company of America, causing some people to doubt the advisability of permitting the production of a single commodity to remain in the hands of one large and coördinated group. But let's take a look at some figures and facts.

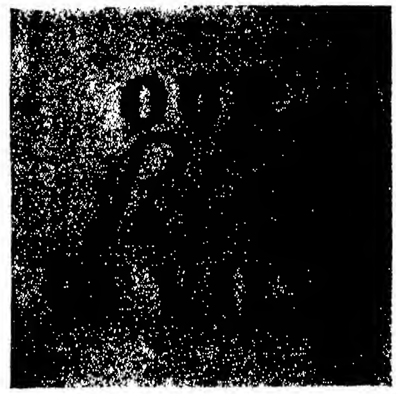
When, in 1886, the Hall electrolytic method of extracting aluminum was developed, the raw metal price dropped from some $16 a pound to $5. By 1925 the price was down to 27 cents a pound, by 1939 to 24 cents, and by 1941 to 17 cents. So much for cost. How about production? Without going into history, it is sufficient to state that aluminum production more than doubled from 1929 to 1940; in the former year it was 200,000,000 pounds annually, while in the latter it was 413,000,000 pounds annually. Projected figures show that, contrary to widely published reports, aluminum production is now, and will continue to be, well ahead of demand. In January 1941 this was in the ratio of 52 to 47 (millions of pounds per month). By January 1942, it is estimated that the ratio will be 66 to 61, and by July of the same year 70 to 61.

Where, then, is the discrepancy, the basis for charges of restricted production, insufficient supplies? Apparently it arises in the reports that some projects, both defense and civil, are being delayed by lack of aluminum. Here it must be kept in mind that the Aluminum Company of America is voluntarily following priority instructions from Washington and cannot guarantee supplies to any consumer not properly taken care of under this arrangement. The Aluminum Company is now the only producer of the metal in this country (but Reynolds Metals Company will enter the field next year), while there are hundreds of fabricators producing a wide diversity of aluminum parts. If only a few of these fabricators find themselves without raw material, there will be sufficient complaints to confuse the issue.

From the figures given above it is safe to say that there is no shortage, present or impending, of raw aluminum, insofar as defense needs are concerned. And no shortage can possibly develop unless unforeseen events transpire. True enough, there is definitely a curtailment of aluminum for certain civilian uses during the peak period of the present emergency. If, however, government and all branches of the industry co-operate fully to prevent too much of the metal from flowing into non-essential channels, every requirement of national defense will be met, with a minimum of suffering on the part of those whose business interests lie in civil fields. —*A. P. P.*

EXPERIENCE VERSUS INTELLIGENCE

THE right man for the right job is a problem that has bedevilled business and industry from the very beginnings. In isolated cases some effort has been expended in an endeavor to solve the problem in a sane, equitable manner, but, for the most part, jobs are still filled on the basis of experience on the part of the applicant. If, in the past, he has had experience in the type of position that is open, he probably gets the new job. If experience is lacking, he doesn't.



Is this system fair either to the employer or employee? Not entirely, and on it rests much of the blame for the many square pegs that are trying to fit themselves into round holes. Of far more importance than experience is the prospective worker's intelligence, adaptability, mental capacity. Experience, of course, will allow him to muddle along in a routine job, turning out a mediocre performance. Intelligence, and all that goes with it, however, will enable him to grasp quickly the requirements of a particular job and in a short time do it with greater efficiency than the man with more actual experience but less basic intelligence.

Here is where business and industry too often fall down in the matter of providing themselves with satisfactory personnel. Through their own employment departments, or with the aid of employment agencies, they attempt to fill jobs by the old method of listing the applicant's previous experience. This, coupled with name, address, date of birth, nationality, and other relatively unimportant data, is the sole basis on which a man's fittness for the job is determined.

Applied psychology can do much to change this picture, to serve the best interests of all concerned. School systems of the United States have pointed the way toward methods of determining mental capacities of children, as differentiated from their absorption of knowledge. By methods available it is possible to sort human beings almost as surely as the photo-electric system sorts beans, rejects improperly wrapped cigars, or spots imperfect wrappings in a complicated packaging machine. And by sorting human beings properly it is possible to contribute to all phases of business and industry from the happiness of workers to the happiness of the stockholder when dividend day rolls around.

There can be no question about the lack of economy — in whatever terms one may wish to assign to the results — to be found in the inefficiency of employees who, however experienced, do not bring to the job an intelligence rate that makes it possible for them to accomplish their assigned tasks in the best possible manner. Misplaced talent can do as much to slow up production, increase costs, as can the most carefully planned sabotage.

If employers continue to stress experience of potential employees to the exclusion of innate intelligence, they can have only themselves to blame for inefficient operation. Only by opening their eyes and realizing that there are available far better and more efficient methods of placing the right man in the right job can they take full advantage of the rich source of idle and misplaced talent that is available today.—*A. D. R., IV.*

Personalities in Industry

MARGARET INGELS, M. E.

Credited with being the first woman in the world to obtain a mechanical engineering degree, Margaret Ingels claims it was no particular astuteness on her part that led her into the engineering field, but only "plain, dumb obedience to my family's wishes." However that may be, associates who have known Miss Ingels for many years claim that her interest in air conditioning—a direct result of her engineering training—started when she was a youngster. The story goes that when she observed moisture collecting on a cold glass, her curiosity was aroused. Her mother was unable to explain it satisfactorily, so young Margaret resolved some day to find out for herself. When she did find the answer—which is merely the principle of condensation—her interest in science and engineering became even more pronounced.

Miss Ingels' work in the air-conditioning field was recognized recently when she was honored at the Women's Centennial Congress as one of the "pioneers" in the evolution of women's careers in the past century.

Miss Ingels, at present Engineering Editor of Carrier Corporation, Syracuse, New York, is the author of numerous articles on air conditioning for magazines and technical publications. Her lectures on air conditioning, well-known for their clarity and non-technical language, have been attended by thousands all over the country.

Born in Paris, Kentucky, Miss Ingels was graduated from the University of Kentucky in 1916. Known as "one of Dean Anderson's boys" at the University, she later obtained a master's degree in engineering after three years of practical experience and a thesis accepted by Graduate School, University of Kentucky.

The Traffic Engineering Department of the Chicago Telephone Company was the first to employ Miss Ingels, which position she left in 1917 to go with Carrier Corporation in New York. Four years of experience with the pioneer air-conditioning company afforded her a valuable start even over many men engineers.

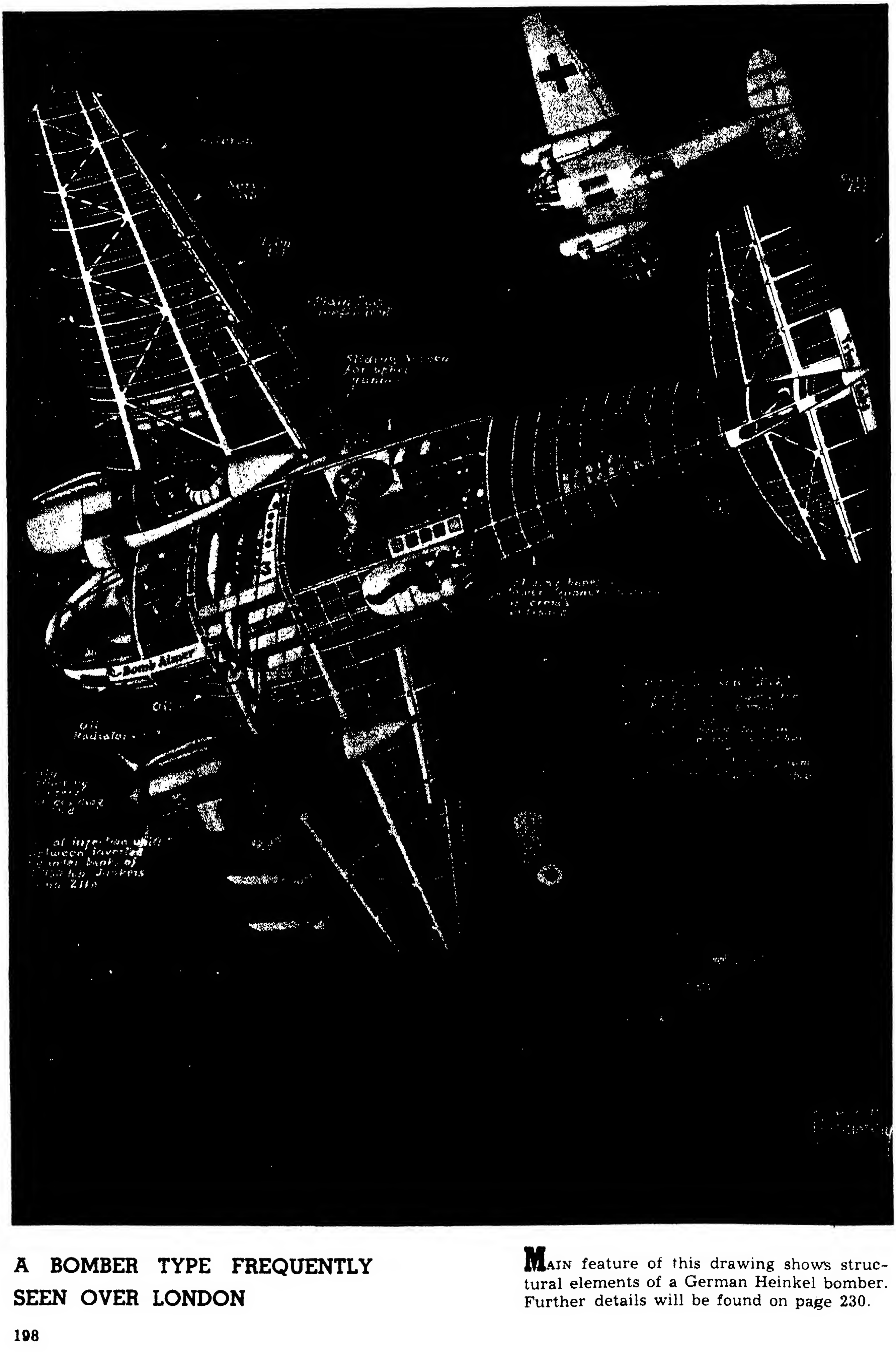
The Research Laboratories of the American Society of Heating and Ventilating Engineers at the United States Bureau of Mines, in Pittsburgh, called her next. From 1921 through 1926, her projects included atmospheric dusts, the infiltration of air through building walls and around building openings, and the physiological reactions of humans in various air conditions. During this time several of her papers on these subjects were published in the transactions of the American Society of Heating and Ventilating Engineers.

Research problems again claimed the attention of the woman air-conditioning expert. This time it was with the New York Commission on Ventilation that Miss Ingels performed field research engineering work in Syracuse, New York. Her study was to correlate health and attendance of school children to various types of ventilating systems.

Since 1929, Miss Ingels has been employed by the Carrier Corporation of Syracuse. Her past experience in the field, added to several years of engineering work in the home office of Carrier Corporation, has provided her with the ability to pass on all engineering information originating in this company.

In addition to these articles and lectures, Miss Ingels' work on air conditioning is cited in the current edition of the "Encyclopedia Britannica," which mentions her findings on the value of the Kata Thermometer in Effective Temperature studies.

Proving that she is not all engineer, Miss Ingels is an expert bridge player and an above-average golfer. An ardent alumna of the University from which she was graduated, she is also a fan and ardent supporter of that school's football team.



A BOMBER TYPE FREQUENTLY SEEN OVER LONDON

MAIN feature of this drawing shows structural elements of a German Heinkel bomber. Further details will be found on page 230.

MILK MADE MORE DIGESTIBLE

Homogenization Eliminates Separation of Cream

BARCLAY MOON NEWMAN

JUST as the Cheshire cat in "Alice in Wonderland" faded until only the grin was visible, so the cream line in homogenized milk is gone—leaving behind, as pleasing though somewhat intangible evidence, a creamy richness spread throughout the milk. The essential change which has been brought about in your bottle of ordinary milk is the perfectly balanced distribution of the cream so that it does not rise to the top but remains in the same concentration throughout.

The cow doesn't give milk with an upper cream layer ready to pour off for your coffee. For this, the baby calf can be thankful; he doesn't have to compete with his brothers and sisters for the cream-layer nutrients which include essential fat-soluble vitamins A, D, and E. It is only afterward, of course—while the milk stands—that the cream line appears. So homogenization is a sort of return to Nature. It provides you, and baby, and the family in general with milk having the nutritious cream and its vitamins as evenly distributed as when first drawn from its source.

The microscope tells the secret. As the eccentric, pioneer Dutch lens grinder and microscopist, Van Leeuwenhoek, remarked in one of his famous communications to his London scientist friends in 1674, milk just as the cow gives it, that is, freshly drawn milk, contains a lot of little globes of fat—fat globules—of different sizes so thoroughly mixed with the rest of the milk that any drop of milk is precisely like every other drop, whether taken from top or bottom of the bottle. Now, allow the milk to stand for a few hours; then examine again through the lenses. The larger fat globules, including those formed by the coalescence of smaller droplets, have risen to ride atop what is now skim milk—milk minus most of the cream and fat-soluble vitamins. This makes it easy for you to rob the milk of the

major part of its creamy richness, fat-soluble vitamins, and best flavor—simply by pouring off the floating globules.

Even in skim milk produced by pouring off the cream layer there are, however, many millions of fat droplets. The very tiniest, still remaining because they are so fine that they do not separate out, are small enough to be held, even after long standing, by weak electrical forces and the weak attraction of the invisible hosts of molecules—protein, milk sugar, mineral salts, water-soluble vitamins—in solution and suspension all around and about.

In freshly drawn milk, the fat globules vary in size from a diameter of 1/250,000 of an inch up to slightly more than 200 times this diameter. The vast majority are less than 1/2500 of an inch in diameter, the average being about 3/25,000 of an inch. The fat globules remaining in skim milk are below this average, and therefore, if you could subdivide all the globules in freshly drawn milk so that their diameters were less than 3/25,000 of an inch, the cream layer would not form. That is, the fat would be in such a fine state of dispersion that the tendency to rise would be counteracted by the weak attractions and electrical forces which hold down the tiny globules left in skim milk.

This idea occurred to the Parisian technologist, Gaulin, and by 1899 he had invented the first homogenizer to break up the coarse fat globules into fine ones and thereby prevent the formation of the cream layer. So homogenized milk—at least as a scientific development—is not new. It is 42 years old, in the technical sense. Hence it has been tried, tested, and perfected, so that, when recently introduced to the public in this country, this new-born infant of the milk industry rapidly grew to giant proportions.

GAULIN'S principle is simple. It may be roughly illustrated by turning on a garden hose, adjusting the nozzle so that the water squirts out with maximum force, and then holding the nozzle close to a wall. The stream of water is "atomized" and a very fine spray flies in all directions. Gaulin set up a bank of hair-fine tubes—capillary tubes—and, using a pressure of 3500 pounds per square inch, forced milk through them and up against a concave metal surface. The larger and even most of the smaller globules were shattered by the force. As later determined, the greater part of the fat was broken into globules of less than 3/25,000 of an inch. To his satisfaction, Gaulin noted that, even on long standing, the homogenized milk formed no cream layer.

Most commercial homogenizers have been developed along similar lines. Several pumps, often as many as six, operating in succession, build up the pressure to 2000 or 2500 pounds per square inch, so that the milk speeds through fine

slit-like orifices at a speed of nearly a mile a second, to strike with a globule-bursting momentum against smooth metallic surfaces. The pressure at which the milk is homogenized is regulated by the size of the openings in the homogenizing valves and, because of the scientifically calculated efficiency of the new machines, it does not have to be as great as the pressure originally used by Gaulin.

High intensity sound waves are also applied to achieve homogenization. The milk flows over a diaphragm made to vibrate with ultra high frequency, and the big globules become little ones as they explode because of violent agitation set up by the inaudible "sound." This particular type of homogenized milk is known as "sonized milk." Properly processed, the product is in all respects like homogenized milk manufactured by the Gaulin method.

HOMOGENIZATION changes the properties of milk in several different and highly advantageous ways. The whole content of the bottle has assumed a creamier, a richer, appearance. This increased creaminess includes an increased viscosity, just as though the milk were thin cream—as you can tell when you pour homogenized milk from the bottle.

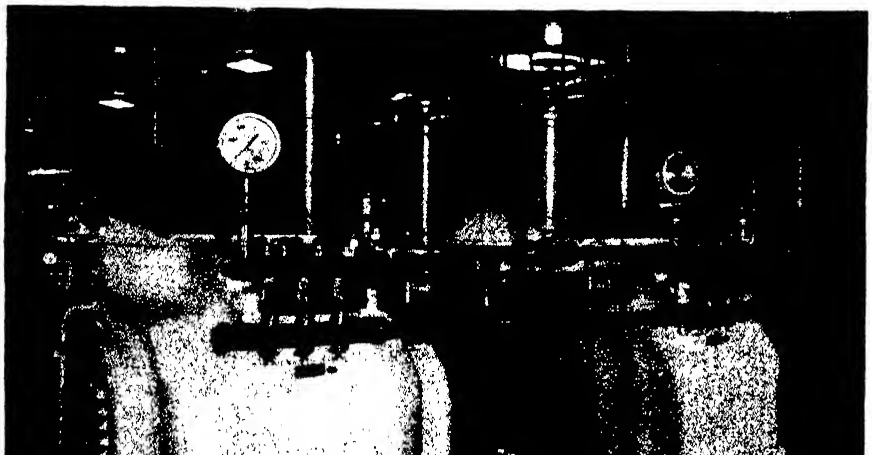
The flavor, too, is altered—improved palatability results from homogenization. Although, of course, "there is no disputing about tastes," since taste preferences are eminently individual, still it has been established by extensive surveys that most people do prefer milk with the new flavor. Taste preferences cannot be measured in the laboratory, but homogenized milk tastes like "cream-rich" milk—just what it is. The best indication of the popularity of the new flavor is to be found in the increased drinking of milk among consumers of homogenized milk. Further, taste idiosyncrasies have kept many persons from drinking much, if any, milk. Now many of these individuals enjoy their milk—homogenized. The universally recognized nutritional and health-promoting values of milk have thus been introduced into the diets of a great number who hitherto denied themselves milk. The health significance is most obvious in the case of children. Health value is attached to any factor that induces a balky offspring to imbibe more of this highly protective food.

Another practical nutritional aspect of homogenized milk has been brought out by authorities on nutrition among school children. One study in schools, where milk is served to children in half-pint bottles, showed that an average of 5.6 percent of ordinary milk is left in the bottle. As the milk specialist, Dr. C. J. Babcock, points out: "This, in itself, would be insignificant, but when we consider that this 5.6 percent of the milk represents nearly 16 percent of the fat in the 4-percent milk served, it throws a little different light on the loss."

The curdometer for measuring the degree of softness of milk curds like those in the stomach

These children—as do so many in schools—drank their milk through straws inserted into holes in the bottle caps. The milk at the bottom of the bottle was thus taken first, and then finally only some of the richer milk and cream at the top. Much of the cream with its vitamins was left.

In the home, babies and older children are not so sure of getting their due quotas of *whole* milk and vitamins from unhomogenized milk as from homogenized. Cream is taken for coffee, or the cream goes into the first glass of milk, perhaps to the nutritional benefit of the maid or cook.



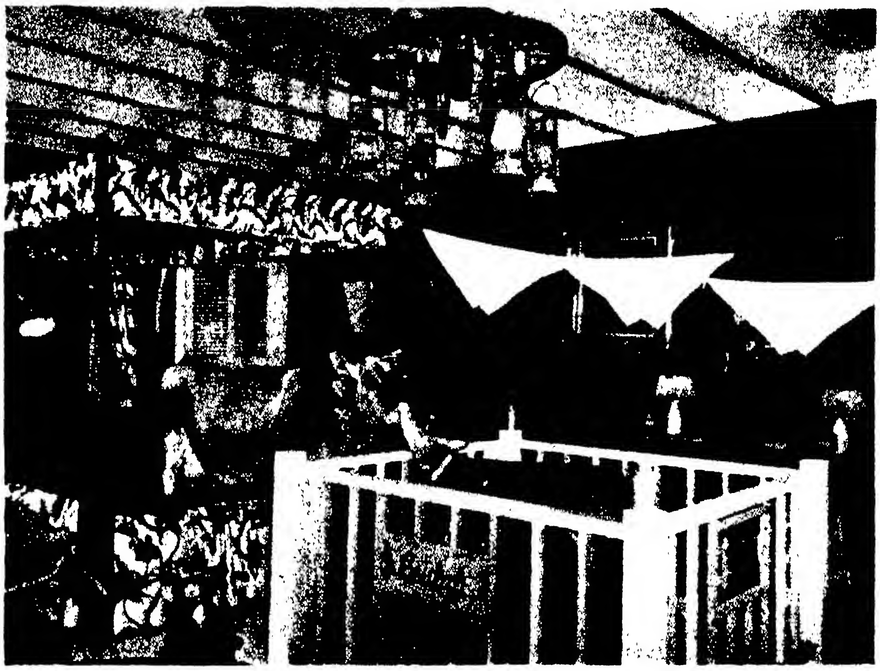
Two homogenizers of the type that work on the Gaulin principle. Inside are driving motors, transmissions, and pressure plungers that work in cylinders in the three-part "heads" seen outside. The milk is squirted at high velocity against solid metal, its fat globules emulsified

OF MUCH greater interest, however, especially to pediatricians, is the problem of curd tension in relation to the advantages of homogenized milk. When milk enters the stomach, the first phase of digestion is a clotting or coagulating process resulting in the formation of curds—hard or soft, depending on the milk and its previous treatment. Milk giving a soft, flaky curd is most suitable for infant feeding and most desirable for adults who may experience an unpleasant feeling of fullness for hours after drinking milk.

The measurement of curd tension provides a means of expressing scientifically the degree of toughness or firmness of the clot or curd. In measuring curd tension, milk is placed in a jar containing a special knife having ten radial arms one inch long and attached to a vertical rod, which is connected with a delicate spring balance.

Clotting is brought about by the addition of pepsin (a digestive ferment from the stomach) and dilute hydrochloric acid. These substances are stirred into the milk, and the mixture is kept warm (35 degrees, Centigrade) for 10 minutes, during which time a clot is formed. Then, with slow, even tension, the knife is drawn through this curd. The reading on the balance, minus the pull of the knife itself, indicates the curd tension, expressed in grams (one ounce being about 30 grams). A curd tension of less than 20 grams (about two thirds of an ounce) is indicative of soft curd milk, according to accepted standards; a curd tension of more than 20 grams indicates hard curd milk. Average mixed milk shows from 50 to 90 grams of curd tension, but curd tension varies in the same cow's milk, is higher in winter than in summer, and may be as high as 200 grams. Less than 1 percent of cows give soft curd milk naturally.

When the curd tension is more than 50 grams, as it generally is in the case of unhomogenized milk, the clot is tough, leathery, and slowly digested. Soft curd milk, on the other hand, is readily made into a loose mush, and therefore is more quickly digestible, as the stomach's motions during digestion can readily intermix the clots with the digestive juices and expose the surfaces of the countless flaky curd particles to the action of the stomach's ferments.



Elsie, the nation's pet, with Hollywood-born daughter Beulah, in their boudoir at the World's Fair. Like all other cows of high, common, or no social rank, Elsie gives homogeneous milk which Beulah thinks ideal, but when filched by man, its fats will soon separate unless homogenized

Dr. Irving J. Wolman, of Children's Hospital, Philadelphia, who has made extensive studies of homogenized milk in infant feeding, tells us: "The process of homogenization reduces the curd tension of milk and renders it of value in infant feeding. But not all homogenized milks are alike. Destruction of the cream line does not necessarily mean a soft curd milk. The homogenization must be done thoroughly and carefully. When that is done, the curds are adequately small, the curd tension comes down, and it is possible to feed such milk with the absence of the symptoms of indigestion attributable to large, tough curds."

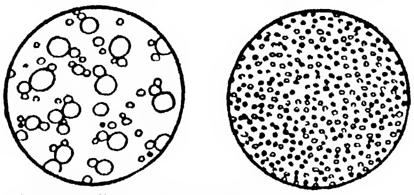
Often homogenized milk is also irradiated with ultra-violet rays to increase its vitamin D content. A typical commercial installation (Borden) as developed by the Wisconsin Alumni Research Foundation. From tank, milk flows in thin sheet over inside of sloping metal flow-boards past the internal ultra-violet lamp

Dr. Wolman's associate, Dr. Leslie A. Chambers, of the University of Pennsylvania, has developed a new device for measuring curd tension—a curdometer—and Dr. Wolman himself has invented artificial stomachs made of rubber, wherein digestion can be investigated under conditions closely simulating those in the human stomach. With this new equipment he has been able to demonstrate more clearly the soft curd characteristics of high-pressure homogenized milk, and to show that homogenized milk is even more quickly digested than ordinary milk—all milk being highly digestible, though speed of digestion may vary.

How can you be sure that your bottle of homogenized milk actually has the cream content claimed, since you can't assay the richness of the milk in the absence of a cream layer? Of course, there is the zeal with which the leading milk companies guard their reputations and the health of their customers. There also is the simple test for butterfat content, and there are the health regulations in constant operation.

THE most convincing tests, however, you can perform yourself. Pour out a glass of homogenized milk; note the creamy appearance

and richness. Taste the improved flavor. Drink, and remark the absence of any feeling of fullness while speedy digestion is going on. Feed it to baby and the other children; they, too, like its increased palatability. Let them continue to drink it, and this important addi-



Courtesy The Borden Company

Homogenization breaks up the fat globules into much smaller ones that cannot rise as cream

tion to their protective diet will have its beneficial effects on their well-being, and aid in the attainment of buoyant health.

Noting these qualities, plus the fact that the whole family gets all the advantages of the bottle of milk, you can readily see why homogenized milk has flowed rapidly across state boundaries, and, already in almost every section of the United States, is being poured from increasing numbers of bottles in more households every day.

• • •

ACID BOGEY

We Do Not Eat Too Many Acid Foods

"WE EAT too many acid foods" is an unfounded idea in which many persons have firm faith. They proceed accordingly, and shun oranges, tomatoes, and other good foods—for fear of acid. The taste is acid, but actually these foods and most other fruits and vegetables have the opposite effect when eaten. They tend to counteract acidity. There is no need to worry about acid-forming and base-forming foods, say the nutritionists of the Federal Bureau of Home Economics, if you have a well-rounded diet that includes plenty of milk, eggs, fruits, vegetables, and cereals with some meat, fish, or poultry. It is better, they emphasize, to focus attention on adequate diets than to fret about acid-forming diets.

Along the same line is the fancy about the danger of eating acid fruits and milk at the same meal. It is true that the acid fruits may curdle the milk, but the digestive juices of the stomach have the same effect. So it is perfectly safe to eat cherries and drink milk at the same meal, and to use orange juice in a milk drink.

Another false food idea is that you should not eat different kinds of fruits together because there is danger in combining the different acids. Nutritionists explain that there is no possible harm in fruit combinations. Nature even combines different acids within a single fruit.

POLIOMYELITIS

Infantile Paralysis Victims Helped by New Operation

USELESS muscles of infantile paralysis victims may be given strength for work by a new muscle-splicing operation recently reported by Dr. Herbert E. Hipps, of the Crippled Children's Hospital, Marlin, Texas, to the National Foundation for Infantile Paralysis.

Muscles paralyzed by infantile paralysis sometimes fail to work because of bands of diseased tissue within the muscles, Dr. Hipps and associates discovered. To repair such muscles, he cuts out the bands of diseased tissue, or weaves through them strips of tendon from the bulky part of the muscle, sewing these strips into the good muscle bulk below and above the paralyzed muscle. In six out of 12 cases, good results were obtained with the operation.

Dr. Hipps suggests that if the muscles of an arm or leg are large and firm, yet graded "poor" or "trace" in respect to function, they will probably show the irregular degenerative changes that might be helped by the operation. If, however, the muscles are soft and small, or if no knots are felt, a general degeneration may be present, and the splicing or grafting operation probably would be of no avail. —*Science Service.*

CUT NERVES

Cuff Made From Artery Used to Mend Cut Nerve

THE ends of small nerves that have been cut can be reunited by holding them tightly together in a cuff made from a fragment of an artery, Dr. Paul Weiss, of the University of Chicago, reports in *Science.*

In the case of very tiny nerves, Dr. Weiss states, neat stitching to hold the cut ends together "becomes a mechanical impossibility." Holding these little nerve ends together by ordinary sewing can never be precise enough, he says, to prevent masses of nerve fibers from "escaping into the surroundings and straying off to uncontrollable destinations." These undesirable results, he says, can be avoided by the use of the artery cuffs.

GERM-FREE BATHROOMS

Ultra-Violet Rays Insure Cleanliness

AKING use of the now well-known sterilizing properties of ultra-violet rays, a device has been developed in the General Electric Company's laboratories for use in sterilizing bathrooms of hotels. First put to practical application by the Hotel New Yorker, this sterilizing device consists of a number of ultra-violet ray generating tubes mounted in a portable unit of the type shown in one of our photographs.

After a guest checks out of the hotel, and the bathroom has been

Sterilizing the hotel bathroom

cleaned by conventional methods, the portable unit is wheeled into the bathroom and placed in operation for 10 minutes. It is then withdrawn from the bathroom and the door is sealed shut by a strip of cellophane, insuring that the bathroom will remain sterilized until the next occupant arrives.

It is claimed that laboratory tests have shown that the Protecto-Ray, as the device is called, is more than 99 percent effective in killing air-borne germs.

BROWSING with the Editor

RATIO OF TWELVE TO ONE—Facts indicate [See also page 214.—*Editor.*] that for each pilot of an airplane in the air, 12 men are needed for ground maintenance work. A defense program involving 50,000 pilots would therefore necessitate 600,000 mechanics, of which only about one in five need not be highly skilled. With a national requisition for a half million real aviation mechanics facing the country, and with only about 40,000 now in the army, the personnel problem becomes tremendous and of vital importance.—*The Tech Engineering News*, January, 1941.

TRACTORS DONT EAT—An estimated increase of 500,000 tractors on American farms during the next ten years will replace approximately 1,500,000 horses and mules. This, in turn, will release for other uses over eight million acres of ground that are now used for pasturage and for raising the necessary hay and grain to feed these animals. —United States Department of Agriculture.

MUSKRAT CROP—The State of Louisiana contains 3,000,000 acres of marshland which produce as high as 10,000,000 muskrats annually. There are 2000 trappers, almost all Acadians, few of whom can read or write, and even fewer of them can speak English. The law allows each trapper 250 traps, and the total income from the Louisiana muskrat industry reaches the fabulous sum of nearly six million dollars a year.—"The Geese Fly High," by Florence Page Jacques.

FROST DOES DAMAGE—Concrete attacked by frost before it has set will harden, but loses up to 50 percent of its strength.—*Highway Research Abstracts*, January, 1941.

YARDSTICK FOR PROGRESS—"Conservation of our national resources" is a phrase applied to methods of preservation and rehabilitation of both inorganic and organic wealth of the nation. As evidence of progress in the latter field, in 1939, the last year for which records are complete, 6,000,000 farmers, operating farms comprising 78 percent of the country's cropland, improved their soil by putting back into it 640,000 tons of phosphate. They applied nearly six million tons of lime, planted 26 million acres of cover crops and green manure crops, planted 41 million acres of new seedings of legumes and grasses, and protected 26 million acres of cropland by contour farming, strip cropping, and modern fallow methods. In addition, they built 354 million feet of terraces, enough to reach two and one-half times around the world.—United States Department of Agriculture.

MATTER OF TIME—If five gallons of gasoline in the tank of your car were an explosive, such as is used in bombing, it would contain much less energy than the gasoline contains; but, since the energy of an explosive is expended in about a twenty thousandth of a second, its rate of expenditure is something like 4,000,000,000,000 horsepower *while* it is actually expending energy.—Prof. D. Bernal, *Engineering* (London) December 27, 1940, page 514.

PHONE CALLS—One phone call a second, 35,000 each working day, are handled automatically by what is conceded to be the world's largest private telephone exchange, located in the East Pittsburgh Works of the Westinghouse Electric and Manufacturing Company. There are 3000 dial phones in the system.

SQUARE OF THE VELOCITY—Striking a solid object at 25 miles an hour will do a car about the same damage as if it had been driven off a two story building. Encountering a stone wall at 50 will be just as serious as if the car had dropped eight stories. A car can make only one fourth as sharp a turn at 50 as at 25, one ninth as sharp at 75 as at 25.—*Stone and Webster Bulletin.*

BEST ASTRONOMICAL CLOCKS—A Shortt clock ran a year so accurately that its accumulated error was only seven tenths of a second, which represents an accuracy of one part in 30,000,000. Another, in the Paris Observatory, had an accumulated error for the year 1927 of only one tenth of a second.—*Journal of the Franklin Institute*, from F. Hope-Jones, "Electrical Timekeeping."

SALVAGING OLD TIRES—A plan is under consideration whereby old used tires are to be salvaged through dealers to economize on raw materials. If consummated, users of tires will be asked to return old tires through their dealers to manufacturers where the old tires can be reconstructed in the original molds at nominal cost.—*India Rubber World*, December 1, 1940.

TINY TUBING—Ingenuity of American technicians has resulted in the production of the world's smallest metal tubing. The outside diameter is less than .0019 of an inch, wall thickness .00075 of an inch, and inside diameter .0004. One pound of the tubing would reach eighteen miles.—*Rose Technic*, October, 1940.

THAT ANSWERS THAT—In his book, "Forecasting Weather," Sir Napier Shaw illustrates a typical atmospheric depression, or "low," of the kind which is involved regularly in our weather changes, and states that its formation required the removal elsewhere of 190,000,000,000 tons of air, the Sun, of course, being the ultimate prime mover in such instances. Commenting on this fact, D. Brunt states that this affords the appropriate answer to the question so often asked, "When shall we be able to control the weather?"—the answer being, "When we are able to stop a mass of 190,000,000,000 tons from going on its own way."—*Nature* (London), December 28, 1940, page 819.

NATURE'S PRODIGALITY FOILED—The female trout scoops a bed in the sand and lays her eggs, but the process is wasteful, for it is doubtful whether more than a fraction of 1 percent of the eggs hatch. In the commercial fish hatchery, however, at least 85 percent of the eggs will hatch.—*Oil Power*, January, 1941.

SHIP BUILDING—A report from the American Bureau of Shipping states that on September, 1940, there was under construction in United States shipyards, to Bureau classifications, vessels to the extent of 1,558,720 gross tons.—*Engineering*, November, 1940.

It's Done With Melamine

Plastics, Surface Coatings, Improved Paper and Fabrics, Stem from Laboratory Curiosity

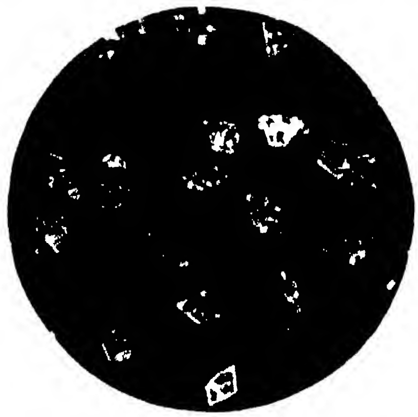
A. P. PECK

YESTERDAY a rare chemical available only in minute quantities at a nominal price of $40 a pound; today an important industrial chemical available in carload lots at a cost of about 40 cents a pound. Yesterday of no known value; today the base of a whole group of plastic products that are invading a broad range of industrial fields. That, briefly, is the story of melamine. And behind its spectacular rise to fame is a story of industrial accomplishment that may be considered as typical of modern applications of science to industry.

Available today are melamine plastic dishes that are non-shatterable, light in weight, resistant to the effects of foods and beverages: at the time of writing one of the major airlines is waiting delivery of a full complement of dishes for their ships. The use of melamine resins in finishes for automobiles makes possible enamels which are quickly applied, inexpensive, stand up remarkably well under the abuse to which the average motor car is subjected. Paper treated with melamine resin can be made waterproof, as strong when wet as when dry. Fabrics are rendered crush-proof, are given fine finishes and the "handle" of far more expensive goods, by the application of melamine emulsions.

BACK in 1834, Liebig produced a crystalline material which, analysis showed, contained only carbon, hydrogen, and nitrogen, and behaved as a weak base. He called it "melamine," and promptly turned his attention to other and perhaps, to him, more important researches. For over a century melamine remained a laboratory curiosity about which little more was known than had been found by Liebig. Only during the last five or six years has any particular attention been paid to this chemical, and only within the past two years has it been considered as a possible chemical of industry.

Several years ago however, one of the chemists of the American Cyanamid Company, studying the possibilities of the amino group of chemicals, procured a small quantity of melamine and started to put it through its paces. Here was no hit-or-miss research, no groping in the dark, however. The chemist was working toward a definite end, although at the start the path was far from clear. American Cyanamid had, for many years, been producing "heavy" chemicals for use in mining, as well as fertilizers and other materials based largely on calcium cyanamide. With this background of knowledge, research was being conducted toward the end of finding new fields, new products that could be made from this basic raw material or from by-products of manufacture. Chemically, melamine offered possibilities.



Melamine crystals photomicrographed, reflected light, 15x

Easy as it is to tell of this research, the actual processes were far from simple. Soon, however, two important facts were determined: Plastics with highly desirable characteristics could be made from melamine; melamine could be made in commercial quantities from calcium cyanamide by the initial production of dicyandiamide. In the beginning, melamine offered obstacles that seemed to be a definite bar to ultimate success. It is only slightly soluble in water (0.5 percent at 25 degrees, Centigrade); it melts only at the relatively high temperature of 354 degrees, Centigrade; it is insoluble in inert solvents. Here were properties that, highly desirable in a finished plastic, presented immense difficulties in development work.

It was soon found that by combining melamine with an aldehyde—formaldehyde, for example—a plastic material was obtained that could be shaped and set under heat

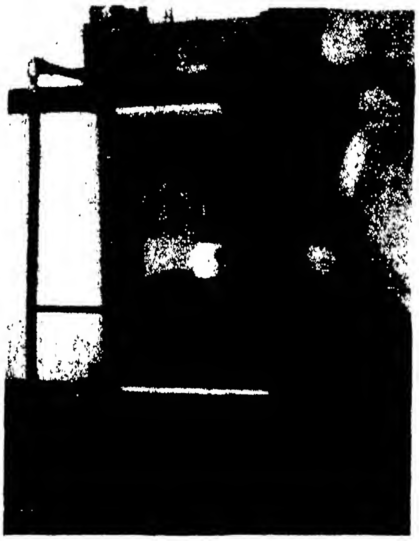
Pilot plant where melamine resin is made on a small manufacturing scale

and pressure. And the resulting plastic had in a still greater degree those properties of heat resistance and insolubility that had, for a time, made the research so unpromising. By adding color pigments to the plastic, which is colorless, it is possible to produce an almost unlimited range of colors in the finished product. In commercial practice, a filler, usually of a fibrous nature, is added to the melamine plastic before heat and pressure are applied. This filler serves to reduce final cost, to add strength and bulk, without detracting from the desirable properties of the pure plastic.

When the research laboratory had established the practical possibilities of melamine plastics, the job was only partly finished. Now that they had it, what could be done with it? What use could be made of its advantages? What were its limitations? The laboratory could produce only small quantities of the material, sufficient for its own experimental purposes but far too small to study the problem in all its ramifications. And right here is ample proof of a statement attributed to Charles F. Kettering, dean of research workers. "The chemical industry," said Mr. Kettering, "is the only one that has learned how to bridge the gap—the shirt-losing zone—between science and production by means of the pilot plant." Working on a small scale, it is possible to solve in advance many of the problems of commercial production, long before large and expensive plants are built. With these problems solved, production can be started on a large scale with full assurance that a minimum of trouble will be encountered.

Preparation of melamine molding compound in the pilot plant

Melamine is a case in point. The laboratory had proved its worth. A foundation had been laid. With the knowledge acquired in the laboratory, melamine passed to the pre-pilot plant stage in the Stamford, Connecticut, laboratories of American Cyanamid. Here it was produced on what might be termed a large laboratory scale. Where the research men produced grams of melamine, the pre-pilot plant produced pounds. With relatively inexpensive equipment sufficient production could be established to make possible an expanded study of the plastic and its possibilities. The output of this section was delivered to fabricators, manufacturers of plastic products, so that they could see for themselves how best to handle this newcomer in the plastics field.



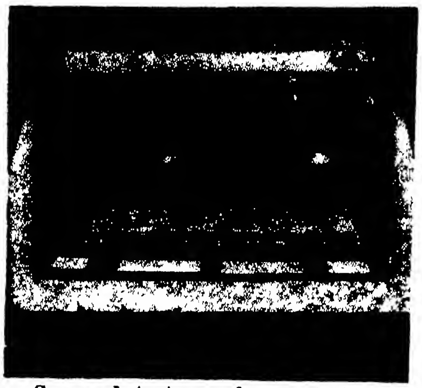
Melamine plastic drinking glasses being molded in small press

Thus were questions answered, production problems solved. Even yet, however, full commercial production of the raw plastic material was not ready. The pre-pilot plant was merely a large-scale laboratory. How would certain types of equipment behave when production was stepped up from the pounds of pre-pilot production to the tons of commercial manufacture? Next step, then, was the pilot plant, actually a factory in miniature. Here it was still possible to experiment on a relatively small scale, to avoid huge investments in equipment that might have to be changed, rebuilt, even junked. Here, too, it was possible to make the larger quantities of the material demanded by fabricators as they developed uses for the new material. From the pilot plant to full commercial production is the last step of the chemical engineer, the last plank in the bridge over the shirt-losing gap.

Test panels are automatically sprayed with melamine enamel

Even after the laboratory passed along to the pre-pilot plant the knowledge that it had unearthed about melamine, its job was still not complete. A plastic material had been produced, but was that the end? Could anything else be done with this material? A promising field was that of surface coatings, paints, if you will. Many years ago the automobile industry abandoned paint-and-varnish finishes for motor cars in favor of nitro-cellulose lacquers. Production was speeded up, finishes were improved. But nitro-cellulose lacquer is expensive; the solvent, which is not even present in the surface coating of the finished job, had to be a material which, even in mass production, could not be reduced in cost below a figure that was still high. Melamine resin, on the other hand, could be made into paint, by the use of a cheaper vehicle, that would bake quickly to a surface coating that was virtually scratch-proof, was resistant to all of the deteriorating factors to which the motor-car body is exposed.

Gas stoves and refrigerators offered another field for melamine. Here, again, the time-honored porcelain enamel finish is expensive, not too durable when Junior wields his toy hammer. It must be baked for long periods of time; if temperatures are raised to decrease



Sprayed test panels are baked under infra-red drying lamps

baking time, discoloration appears, which increases production costs. When properly compounded, melamine resins can be used to produce white baking enamels that have definite advantages of short baking periods. Where porcelain enamels require several hours in the ovens, melamine resin enamels can be baked in half an hour at only 250 degrees, Fahrenheit. Yet this enamel, in service, will resist prolonged exposure to temperatures of 425 degrees without loss of either gloss or color.

Still another new use for melamine resins is in the treatment of paper. Outstanding water resistance can be obtained; paper towels, treated with melamine resin, are as strong when wet as when dry, yet their absorption of water is hardly affected.

In the fabric field, melamine resins can do a variety of jobs. By applying emulsions of the resin to cloth that has already been dyed and printed, it is possible to obtain a wide variety of finishes. For example, one result with spun rayon and velvet is an uncrushable fabric that can be twisted, knotted, or otherwise crushed and that will, when released, spring back to its original form with no creases whatever, or with only minor creases that will shortly disappear if the fabric is hung up. Then, too, these same resins, differently compounded, will produce fabric finishes similar to the well-known sizes, yet that will not wash out or disappear under the rigors of dry-cleaning. Or the finish may be so made that it can be inexpensively applied to cheap goods, giving the appearance and "handle" or feel of a much higher priced material.

It must be understood that melamine resins are not alone in the fields that have been described. Other synthetics have been developed and experimental work with them is being conducted in similar fields. Melamine resins under the Melmac trade mark, however, are products of which you are going to hear much more in the near future. Their development is still so new that their ultimate place in industry can hardly be evaluated at this early date. That they have certain advantages over other plastics is clear; that they will find their own level and contribute their part to consumer satisfaction is equally clear.

• • •

INSULATION TEST

Mechanical "Finger Nail" Checks Wire Insulation

A NEW, portable, testing device for the rating of film-type wire insulations depends upon the time required for a needle acting as a mechanical "finger nail" to wear through to the metal underneath. Contact between needle and wire closes an electric circuit and the device stops automatically. J. A. Weh, of the General Electric general engineering laboratory, designer of the instrument, is pictured with it.

The side of the needle, of the ordinary sewing type, is used. It is held firmly against the wire by small weights and is driven back and forth by an eccentric mechanism connected with a counter to record the number of scrapes. An electric motor furnishes the power. Only a few inches of wire are required for a test. The instrument may be used to study any kind of enamel or films used on wire.

Power-driven sewing needle acts as human finger nail in tests

In previous tests of this character, the wire was either pulled under a scrape edge or attacked by an abrasion drum. In the latter case, it was difficult to maintain a constant abrading surface and the former gave inconsistent results with the new tough films, due to alternate gouging and skipping.

SHELLAC FORTIFIER

Improves Results With This Coating

SHELLAC has one major fault and particularly when used as a coating on surfaces that are to be abraded, such as floors. Adding to shellac an equal quantity of a new compound called Master Shellac Fortifier increases the resistance to abrasion more than four times. The resultant mixture will also dry harder in less than half the time required for ordinary shellac.

The mixture has particular value in foundries since the Fortifier prevents sand sticking even when hot sand is used; patterns and coreboxes on which Master Fortifier has been used are from three to five times more moisture-proof than they would be if regular shellac were used.

SAFETY GLASS

Tougher, Can Be Nailed in Place

A NEW safety glass having a strength of ten or more times that of ordinary automobile safety glass has been developed by the Pittsburgh Plate Glass Company.

The new glass, called Flexseal, was developed initially for use on sub-stratosphere airplanes, whose pressurized cabins require strong and tightly sealed windows, which, if broken, will not leave the frame or release the cabin pressure. Because of its unique properties and many possible variations, use of Flexseal should prove advantageous in many other applications.

In Flexseal laminated glass is combined the toughness, strength, and elasticity of a special plastic, and the hard surface, good vision, and rigidity of a special heat-strengthened glass. Like ordinary safety glass, Flexseal is a glass

sandwich in which one or more thick slices of vinal plastic serves as the "meat," but in this case the "meat" extends beyond the edges of the glass and serves as a flexible and rubber-like edge that can be bolted, screwed, or even nailed into window openings.

If the glass is broken, the thick plastic layers securely attached to the frame serve as an air-tight diaphragm, maintaining the inside and outside pressure differential, an important factor in the airplanes mentioned previously.

Flexseal laminated glass is the realization of a long dream by the glass industry for a mechanical method of fastening glass to other materials with a strong and airtight seal. Flexseal, when bolted tightly in a frame, is not affected by localized stresses as has always been the difficulty with rigid glass.

In effect, Flexseal is a plastic window on both sides of which is "floated" a light of glass. When installed, Flexseal has the appearance of an ordinary home or automobile window, but, unlike present windows, it does not tend to break when the frame is twisted.

MILLING ATTACHMENT

Head Mounts on Lathe Bed, Table on Lathe Carriage

SHOWN in one of our photographs in position on a lathe bed, a new milling attachment employs the lathe spindle for its drive and makes use of the carriage movements to operate its table. The spindle is carried on a vertical slide so the spindle can be positioned, or moved up and down. Among other accessories, enabling the operator to cover a wide variety of work, is a ball-bearing arbor support for attachment to the lathe tailstock spindle so a cutter arbor can be applied in a manner similar to that on a standard plain milling machine with an overarm. It also is possible to mount a chuck on the end of the arbor at the milling head in raised position and set a standard lathe tool on a block on the carriage to swing larger work in a turning operation than the lathe will take on its own headstock.

Milling head makes vertical, horizontal, and longitudinal cuts

Originally developed in 1939 and distributed in the Southern California district only, this tool is now available nationally for Atlas and Craftsman lathes (other than 6-inch sizes), 9-inch and 11-inch South Bend lathes, and 10-inch and 11-inch Sheldon lathes. The milling head may also be attached to other makes of lathes, and larger sizes of lathes, by the use of a special adapter base plate, a slight change in the crossfeed screw nut, and necessary machining of the base of the column and the table.

ENGINE COOLING

Airplane Cylinders Cooler When Enameled

CONTRARY to an idea that coatings of paint and enamel act as insulators and keep heat in cylinders of airplane engines so treated, the coatings actually increase their rate of cooling. This fact has been brought out in experiments made by Dr. Myron A. Coler, technical director of the Engineering Products Division of the Paragon Paint and Varnish Corporation, reports *Science Service*.

Many factors entered into the cooling efficiency, Dr. Coler found. The color of the enamel proved important. One that was clear raised the cooling rate as much as 13 percent, though even a black enamel produced an improvement of 7 percent.

Another surprise was found in the effect of more than one coat. "If the coating material functioned as a simple insulator, we would naturally expect the cooling efficiency to drop with increasing coat thicknesses," said Dr. Coler. "However, it must be remembered that the properties of such materials in the form of thin films may differ considerably from those of the same materials in massive forms."

While a layer of asbestos paper around a test cylinder reduced the cooling by 4 percent, one coat of enamel increased it 13 percent, two coats 20 percent, three coats 23 percent and four coats 24 percent.

BALANCING

Sensitive Machine "Feels" a Minute Unbalance

IN THE manufacture of spinning buckets for use in making rayon filaments, it is necessary that the buckets themselves be accurately balanced in order to produce satisfactory operation. To achieve the required degree of accuracy a machine has been developed in the Micarta Division of the Westinghouse Electric and Manufacturing Company which "feels" an unbalance of as little as 3/1000 of an ounce in the bucket. One of our photographs shows this machine in operation. As the spinning bucket rotates at a speed of 8000 revolutions per minute, the large meter at the top of the balancing machine indicates any error that exists and tells where the plastic bucket must be trimmed to bring it into balance.

Sensitive to 3/1000 of an ounce

MAGNETIC GAGE

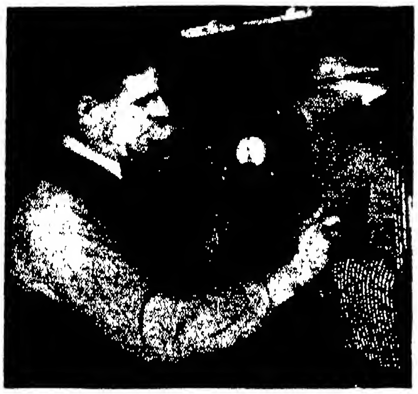
Tells Thickness of Auto Body Enamel

SCIENCE has produced many delicate precision gages in recent years to help the automobile industry build better cars. Not the least ingenious of them is a magnetic device that measures the thickness of the paint film on the car body and fenders.

This instrument is now being

used by the Ford Motor Company as a new means of insuring surface luster and color for the life of the car. It measures the total thickness of the paint and unless the film is sufficient for maximum durability, the paint job is rejected.

Although measuring the thickness of paint without damaging it would appear to be a complicated task, the principles involved in the gage are simple. Two electric cords



Finds thin spots in auto enamel

lead from a small metal case. One is connected to a power line and the other has a small spool-like measuring head attached to the end.

By touching the measuring head to a flat or curved painted surface, an indicator is activated on a meter in the case. The strength of the magnetic field, which varies according to the amount of paint between the magnet and the body metal, is registered on the meter. The thinner the paint, the greater is the magnetic field, and vice versa. An accurate reading on coatings as thin as one thousandth of an inch is obtained instantly.

RUBBER SUBSTITUTES

Difficulties Encountered in Practice

SYNTHETIC rubber cannot "be universally substituted for the natural product," report L. B. Sebrell and R. P. Dinsmore, of the Goodyear Tire and Rubber Co., according to *Science Service*. It is, they stated, "a material having special properties which, when properly handled, will give improved results as compared with natural rubber. On the other hand, we should look upon it as a material whose development and perfection will liberate us from the threat of embargo of natural rubber during the time of national emergency and as a guarantee that the price of the natural product will never again reach the peaks which have characterized it in the past."

Although synthetic rubbers possess elasticity and resilience, they differ considerably, it was said, in molecular makeup, and it ought not to be expected that they will process just the same way as natural rubber. Their study, they qualified, is limited to synthetic rubbers capable of vulcanization.

"By far the most serious aspect of the successful use of these rubbers is their difficult processability," Messrs. Sebrell and Dinsmore averred.

For severe service in tire treads, certain synthetic rubbers were recommended by the authors, who added that they cannot, at present, be expected to equal natural rubber. None of the synthetic rubbers, they said, is the equal of natural rubber in rebound. "Synthetic rubber," they declared, "cannot be substituted for natural rubber on a quantitative basis or on an equal cost basis without examining carefully the physical properties which are to result from such a procedure."

TEST RIG

Variable Speed for Wide Use Range

TESTING generators, governors, vibrators, pumps, bearings, and a host of other specialized equipment, is one of the problems of present day industry that has been recently solved by a new variable-speed test rig developed by the Link Belt Company.

With this device, which is completely adjustable to take almost any type of machine to be tested, tests can be made for determining whether the equipment under test runs true, functions efficiently, carries the load properly, and for calibrating.

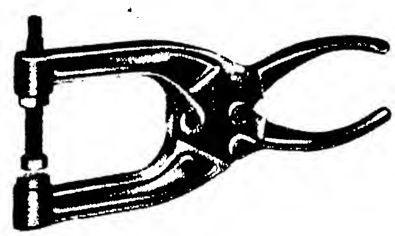
For industrial testing

The mechanism to be tested is connected to a power source through a variable speed transmission which is capable of an infinite number of adjustments.

PLIERS

Automatic Lock Holds Position, Releases Instantly

GREAT length of throat on a new rapid-action toggle pliers permits work being held several inches from the edge of a sheet or board.



Deep throated, automatic locking

In the model 450, illustrated in these columns and recently announced by Knu-Vise, Inc., the throat has a capacity of 1½ by 3 inches.

This type of pliers has a pressure ratio of 93 to 1 and is made of hardened and tempered forged steel.

In operation, the toggle pliers are not bolted or welded to a fixture, but are manually applied by squeezing the handles. The handles automatically lock in position, thus holding the jaws with a positive grasp, yet the pliers can be instantly released when desired. The jaws will not "walk" or "creep" and can be adjusted to accommodate different thicknesses of material by means of a screw in the upper jaw.

NEW PAINT

For Highly Corrosive Conditions Has Synthetic Base

A NEW grade of paint, named "Koroplate," developed to protect metal surfaces against chemical reactions and recommended for service wherever extremely corrosive conditions disqualify any other kind of paint or coating, has been produced by The B. F. Goodrich Company.

Base of the paint is Koroseal, a

(Please turn to page 237)

INDUSTRIAL TRENDS

THE VITAMIN INDUSTRY

No passing fad or fancy is the growing emphasis on vitamins. Freakish dietary fads come and go, frequently doing far more harm than good, but the health-promoting properties of vitamins have been so definitely established by medical science that vitamins have long since passed the stage where even the most sceptical might look upon them askance. And around these still mysterious elements of our daily diet has grown a thriving industry founded upon a solid base of scientific research.

It is not the function of this page to inquire deeply into the medical aspects of any subject, but it might be well to review briefly some of the salient facts regarding vitamins. These organic substances themselves contribute nothing to the human body in such matters as energy or building materials. Nevertheless they are indispensable to normal nutrition. Only minute quantities of them are needed by the body but, strangely enough, the body itself cannot manufacture even these small requirements. On the other hand, green plants and certain animals can produce vitamins in the natural course of events and vitamins can be manufactured synthetically. It is the latter fact that is of the greatest interest at the moment.

Vitamin A, the substance that helps to build resistance to infection and prevents certain forms of blindness, is present in some vegetables and in the livers of animals and fish. Vitamin B, which is in reality at least six different substances that occur together in varying proportions, has been found necessary for the health of the nerves and the heart. A deficiency of vitamin B affects the appetite and the whole digestive system. In this group are included thiamine, nicotinic acid, pantothenic acid, and other chemicals. Then there are vitamin C, which prevents scurvy, D which prevents rickets, and E and K.

All these vitamins are now available for general use, either in the form of synthetically manufactured chemicals or as concentrations of natural products. And the end is by no means in sight. It is certain that other vitamins will be discovered and synthesized; as they are found they will add that much more to the vitamin industry.

Stellar example of the effect of research on the production of vitamins is thiamine, known as vitamin B_1. Only a few years ago a gram of this chemical cost $700. Today the same quantity can be produced for only 80 cents. Better still, from the consumer's standpoint, is the fact that only a gram of this substance is needed by the human body in the course of a year. Similar cost reductions have been made in other vitamins, bringing directly to the public the beneficial results of scientific research conducted in co-operation with reputable manufacturing concerns.

The vitamin industry is not to be confused with any of the mushroom growths that have, from time to time, been built up around quackery and nostrums, only to die off rapidly or to find a level where none but the uninformed could be persuaded to buy. No high-pressure tactics are used by the few ethical drug manufacturers who, in collaboration with the medical profession, are making these products available to the general public.

Not only are vitamin concentrates available for use where deficiencies occur, but they are also being used in foods to insure that a balanced diet will provide the body with the nutriment needed for health. Thus, it is promised that soon—probably by the time this note is being read—there will be available, in most localities, bread made from vitamin-enriched flour. This flour, according to a report from the National Research Council, "will contain thiamine, nicotinic acid, and iron in amounts corresponding to or even higher than those in stone-ground flour from high-vitamin quality wheat."

Although knowledge of vitamins dates back to about 1881, no real progress was made until early in the present century and it has been only a relatively few years since that progress was translated into results that touched the lives of nearly everyone. Some statistics will reveal the recent phenomenal growth of the vitamin industry and give indications of the trend that may be expected in the future. In 1925, according to *Barron's*, vitamin products to the value of $343,000 were produced, representing 0.1 percent of the entire drug and medicine industry. By 1939, these figures had climbed to $41,645,000 and 11.7 percent, and every indication is that 1940 (figures not yet available) will show further substantial increases.

ANOTHER SYNTHETIC FOR MILADY

Vinyon yarn, a synthetic that emerged from the laboratory several years ago, is about to make its bow to the consumer's market. This material, product of research in the laboratories of Carbide and Carbon Chemicals Corporation, has so far been used only in industrial fields where its qualities of high wet and dry strength and resistance to acids and alkalies have found wide applications.

Report has it that this yarn has been used experimentally in women's hosiery and in bathing suits, but as yet none of these products has reached the ultimate consumer. More definite, however, is the promise of Vinyon gloves, to retail at about a dollar a pair. The fabric will resemble heavy silk and will be easy to clean.

Thus will another trend of the synthetic chemicals industry provide one more stepping stone in the path to the completely synthetic costume for milady.

DIESELS FOR FREIGHT

In the short space of seven years, over 100 Diesel locomotives have been placed in high-speed passenger service on American railroads. Now these challengers to steam enter another phase of their development. Electro-Motive Corporation has built for the Santa Fe railroad two freight Diesels that are in mainline service through the arid and mountainous sections of the West. Advantages that these locomotives hold over steam are elimination of locomotive changes on long runs, fewer stops for fuel and water. Just how far this trend in railroad practice will continue can be determined only after definite cost figures have been accumulated over a period of time. Passenger Diesels have injected new life into the railroads; perhaps these two freighters will do the same for freight traffic.

—*The Editors*

Our Search for the Supernatural

Scientific American Launches an Investigation of the Reality of Psychic Phenomena

In January, 1923, Scientific American inaugurated an exhaustive two-year exploration of the subject of psychic phenomena, both in Europe and in America, in an endeavor to discover a basic, scientific truth upon which the wide-spread belief in spiritism might be solidly founded. Those efforts were fruitless in that no objective spiritistic manifestation of physical character, in the form of a psychic photograph or otherwise, was produced which bore sufficient authority to warrant approval by the co-operating committee, or which was not capable of duplication or explanation by Houdini, then the world's most noted conjurer, and a member of that committee.

Despite the failure of two decades ago, neither science nor the interested public is satisfied today. Although the findings of the earlier inquiry were completely negative in all occult fields investigated, including necromancy, theurgy, pneumatography, and all manner of mediumistic enterprises, both science and spiritistic efforts have materially changed in the past score of years. The sciences of physics, chemistry, and electronics, not to mention many other branches of systematized knowledge, have so expanded their scope as to produce and perfect more accurate methods and instruments of investigation into the unknown. On the other hand, spiritists have laid claim to advancement. Their attempts to converse with the dead, to peer into the occult, have been legion. Outstanding among these, only because of attendant publicity, were the efforts to communicate with Houdini, following his death in 1926, and the use of the medium, Mary Cerrita, in the Lindbergh kidnapping case.

Although both of these instances of so-called spiritistic achievement were later conclusively proved to have no scientific value as mediumistic demonstrations, they served to accentuate man's most basic instinct—to see into the future, to delve into the mystic, in a struggle to determine possible survival after this life. Ever since the dawn of human history man has striven to look beyond the present in a desperate, ever-hopeful venture to learn just what is to come after death. That humans have always been so constituted has given rise down through the ages to belief in the occult, the supernatural. Pre-christian era history, both Biblical and heterodoxical, is replete with evidence of man's attempts to see into and to prognosticate his destiny, to establish contact with fellow beings who had passed on, and the records of the ensuing centuries cite countless efforts to practice necromancy and spiritism in many and varied forms.

History shows that this movement is invariably enhanced in time of war, or during periods of national and international economic and social unrest. Evidence that mental distress and uncertainty is wide-spread in the United States and throughout the world is apparent on all sides. It has reached the editors of Scientific American in varied forms and in increasing volume. Underneath the constant query concerning what lies ahead next week, next year, lurks a dangerous public trend toward futility—a hesitancy to exercise our long-prized national charactistic of shaping our own destinies. This public attitude, in turn, tends to drive the human mind to extremes in the search for an answer. Failing to find what he feels are satisfactory prognostications in the fully acceptable informative channels of

$15,000.00 AWARD

● SEVERAL years ago The Universal Council for Psychic Research posted an award of $10,000.00 to any medium who can produce any effect in spiritism or any supernatural manifestation, which its Chairman, Dunninger, cannot duplicate or explain through natural or scientific means. To this still standing award, Scientific American now adds $5,000.00 as a further incentive, the Scientific American Committee on Psychic Research (to be announced in the near future) to determine the authenticity of the demonstrations. This combined award of $15,000.00, which will not be divisible or broken up in any way, will continue to be available for two years from March 15, 1941, under the following conditions:

(1) Mediums or others engaging in spiritistic enterprises, who desire to become eligible for the award, must file a written statement with Scientific American's Committee on Psychic Research that any phenomena produced by them are accomplished solely by supernatural, spiritistic, or psychic agencies, and not through trickery, abnormal physical development, legerdemain, or mechanical devices.

(2) Actual demonstrations or attempted demonstrations must be performed in the presence of the Scientific American Committee on Psychic Research, or such of its members and others as may be designated by the Chairman of the Committee.

(3) If subsequent demonstrations or seances are requested by the Committee, or its Chairman, the demonstrator must comply with this request to be eligible for the award.

(4) Demonstrators of psychic phenomena will be permitted to name and to work under their own conditions during the first seance or demonstration, so long as such conditions are compatible with the best interests of the aims of the Scientific American Committee on Psychic Research. However, this Committee reserves all rights to request repetition or duplication of the demonstration or seance under its own conditions, at such time and place as it may designate, and will undertake to the best of its ability to see that its conditions do not hinder or inconvenience the medium or demonstrator. Failure of the demonstrator to comply with the Committee's request to reproduce or to attempt to reproduce phenomena under the Committee's conditions will nullify any claim the demonstrator may file for the award.

(5) The publishers of Scientific American reserve the right to publish any or all of the findings of its Committee on Psychic Research.

(6) Since experiments by Dunninger and others have proved telepathy to an acceptable degree, demonstrations of this nature are not eligible for the award.

The sole purpose of the Universal Council for Psychic Research and of Scientific American in posting this joint award is to offer incentive for co-operation by any person who may be able to assist the Scientific American's Committee on Psychic Research in its endeavor to discover a basic, truthful, scientific explanation of spiritistic phenomena. ●

WATCH forthcoming issues of Scientific American for full reports on this research.

normal times, man inherently or instinctively turns to alleged mystic and secret rites of cults or individuals in a desperately hopeful—but altogether futile, according to scientific investigations to date—endeavor to satiate his desire.

Therefore, because the cycle of human interest in things psychic, motivated by these abnormal times, has again reached the height of its orbit, Scientific American once more undertakes to discover the factual truth concerning mediumistic and spiritistic manifestations. Can we, through mediums, communicate with the dead? Do such things as ghosts, spirits, phantoms, and vampires actually visit us from a supernatural world? What are the facts concerning ectoplasmic demonstrations? Scientific American seeks the scientific answer to these and other spiritistic phenomena.

In this, its second systematic search for the truth, not only is Scientific American continuing its explorations of 1923-1924, but also it will be aided and assisted by close co-operation of the man who guided and advised Houdini in those earlier studies, and who, as Chairman of The Universal Council for Psychic Research, has for 20 years consistently maintained a searching probe into supernatural manifestations. This man, known the world over as the foremost authority on imaginary and illusionary effects, for his phenomenal mental powers, and for his psychical investigations, has completely succeeded in mystifying such masters of science as the late Thomas Alva Edison and Charles Steinmetz.

Six Presidents of the United States have called him to the White House to display his amazing talents. Of him the late Arthur Brisbane said: "The most mystifying and by far the greatest mind reading demonstration I have ever witnessed." He is the man who conceived, demonstrated, and turned over to United States Navy officials his device for camouflaging a warship to the point of invisibility. This astounding person is Dunninger, the world's foremost mentalist, who as Chairman of The Universal Council for Psychic Research, long ago offered a $10,000 award to any dealer in the occult whose "supernatural" feats he cannot duplicate or explain through natural or scientific means. This offer still stands.

It was to Dunninger that Sir Arthur Conan Doyle, Thomas Alva Edison, and Houdini each confided a secret message in code before their respective deaths in order to test the theory of spiritual return to this world. It was therefore Dunninger who exposed the many mediumistic claims of spiritistic communication purported to have come from Houdini after his decease, for none corresponded with the pre-arranged message. It was Dunninger who startingly disclosed that Mary Cerrita, the medium who claimed to reveal through psychic powers vital information in the Lindbergh kidnapping case, readily could and unquestionably did obtain her data from purely natural sources.

It *will* be Dunninger, as Chairman of Scientific American's Committee on Psychic Research, who will actively apply all necessary forms of systematized knowledge in this co-operative endeavor to discover whether scientific truth and facts lie behind so-called "supernatural phenomena." Dunninger will be ably assisted by the members of his committee, and by the entire resources of Scientific American. It cannot be over-emphasized that this proposed inquiry into psychic and spiritistic phenomena in *no* sense questions any form of religious belief, but is solely a scientific study to determine the true facts concerning what have been termed "supernatural manifestations."

—*The Editors*

DUNNINGER

...ore ... that Hou... liar. So he wrote "Robert Houdin Unmasked."

During his career Harry purchased or obtained the patent papers of every lock patented in the United States, Great Britain, France, and Germany, and he knew more about locks than most locksmiths. He was an expert on spiritualism, being advised in these media by Joe M. Dunninger who umpires the claims of those seeking the reward of the Society for Psychical Research for bona fide demonstrations. He made a number of films, but he lacked a good picture personality and they were not too successful.

From "American Vaudeville," by Douglas Gilbert. Whittlesey House

Warbird Doctors

Planes Alone Don't Make an Airforce: It Takes Trained Men to Keep Fighting Pilots in the Air

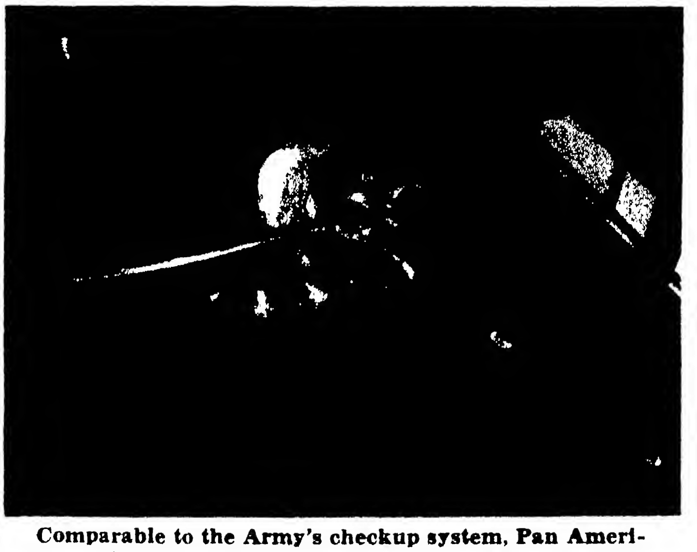
JAMES L. H. PECK

A FLIGHT of glistening fighting planes slides down an invisible sky track toward the big airdrome. The Army's warbirds are coming home to roost. They ease onto the flat turf and, as their landing rolls slow, the nine craft swing their striped tails almost in unison and taxi up to the broad concrete apron in front of the great hangars. The pilot of the silver ship nearest you unbuckles his 'chute harness, takes a form about the size of a sheet of typewriter paper from a metal case in the cockpit, commences writing on it. After the engine runs itself out—one does not quickly switch off these high-powered motors—he climbs from the gadget-filled, glass-enclosed cockpit and hands the piece of paper to the crew chief. The pilot's job is finished; that of the crew chief and his men is just beginning—the job of caring for and feeding these hungry fighters, keeping them "in the pink" that they may fight well.

Khaki-clad men swarm over the oil-streaked ship like worker ants on some fallen bird. Engine cowlings and metal panels are removed, exposing the not-so-beautiful tangle of intertwined cables, conduit, copper tubing, and rods of various sizes. As the crew chief barks orders, you peer over his shoulder at the piece of paper, across the top of which is printed "Airplane Flight Report—Air Corps Form No. 1." Beneath this heading are the pilot's remarks concerning the behavior of his ship's engine, instruments, armament, and radio. Everything has been checked and okayed, so you ask the sergeant—crew chiefs are usually either master sergeants or technical sergeants or those holding some rating—why all the activity if there is nothing wrong with the ship.

"Inspection," he grins, "so that he'll turn in the same kind of report next mission. I'll tell you, that guy who said something about 'a stitch in time—' could have been talking about us."

You nod understandingly. This is a daily inspection, so it seems, which is carried out before or immediately after flight. Oil and gas lines, connections, and clamps are checked for leaks and proper tension, and for wear due to vibration. Fuel strainers are drained and examined for undue clogging. Ignition cables and terminals are gone over for signs of abrasions, broken insulation, and loose attachments. The levers, rods, and bearings of the engine's throttle, spark, and carburetor controls are checked for excess play, improper safetying, or bending. Oil coolers undergo close scrutiny. On planes mounting liquid-cooled engines, such as the 500-mile per hour Lockheed *Lightning*, similar attention is paid to radiators, pumps, and piping. All this is done by engine mechanics under the supervision of a master mechanic. These fellows actually look for trouble before it becomes serious.



Comparable to the Army's checkup system, Pan American Airways maintains extensive repair personnel

In this they are not alone, for elsewhere about the ship airplane mechanics probe for things amiss. Landing and tail wheels are examined for bent rims, damaged hubs, and excess play or signs of wear in brakes; tires are checked for proper pressure, and for cracks, cuts, and wear. Wings, control surfaces, control rods and cables, and the propeller blades and hub mechanism receive their measure of carefully cultivated attention.

Presently the sergeant says, "Want to come along?" You enter one of the cavernous hangars, and he goes to a large chart on the far wall.

"This," he explains, "is number 24's 'income report,' a complete record of what she's done, or had done to her, within the past three months." It is so high that one must get up on a step ladder to make entries near the top, about eight feet from the floor. You can just make out the heading, "Maintenance Inspection Record, Air Corps W. D. Form No. 41." This huge sheet indicates the routine inspections required of all mechanics and officers, and provides for a record of flying hours, supplies, and remarks concerning delays caused by shortage of these supplies or of personnel.

YOU duck beneath several wings and approach a practically undressed pursuit ship in the center of the hangar. "This one's up for the weekly inspection," says the sergeant. Another gang of trouble hunters in khaki are hard at work. Most of them wear broad-peaked caps on the Apache order, only more so. Army men like these caps; even the pilots wear them upon occasion. From what you can see from behind the caps and wrenches, the goings-on appear to be a revised edition of the daily, or "line" inspection, with more attention to detail. For example, one of the men is busy with the plane's battery. He scrapes the terminals and cable, puts it back in the plane, then smears Vaseline over the metal surfaces. He tests the solution with a hydrometer and adds a little distilled water. Another young chap is cleaning the motor's distributor block with gasoline. On the other side of the ship a radio mechanic

is busy checking the tubes and circuit. Then he cleans the antenna. Discovering that one of the antenna insulators is cracked, he replaces it. An instrument technician is giving the dial-filled cockpit panel the once-over. Looks as though the boys have really found some trouble this time.

You say something to this effect to the sergeant. "You ain't seen nothin' yet," he grins. "Come on over here." The pursuit in the corner is having her nose cleaned. Here are more men and caps and wrenches. Tray racks on wheels are filled with a miscellaneous—but far from disorderly—collection of hardware and engine parts. Spark plugs are removed and replaced by ones which have been tested and cleaned. Valve clearances are checked and adjusted. Breaker points are also being checked for clearance. The ship's whole fuel system of copper arteries and veins is being flushed out:

Adjusting motor of a North American BT-9 training plane

its oil system is being drained and strainers and screens cleaned. One of the wheels is being fitted with a new tire. This goes on the record as the monthly inspection, but it is essentially what is known as a "top overhaul"—the biggest job tackled by the squadron's maintenance men.

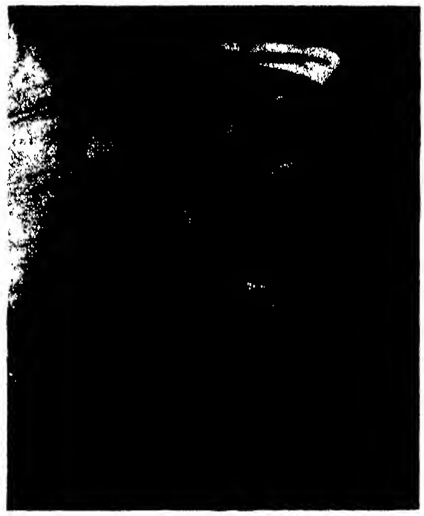
"How would you like to fly up to the depot with us after while?" the crew chief asks. As we walk toward another hangar, he explains that the real heavy work—"major overhauls" and rebuilding—is done at the air depots. We stop to watch the armorers and ordnance men at work on the ships' armament—aerial cannon and machine guns. These weapons have to be right at all times: a warplane sans armament, or whose guns are out of alignment or have a tendency to jam, is about as useful as a parachute specialist aboard a submarine. One of the workers is giving a machine gun what is called an "ordinary disassembly" with a most interesting combination tool. This operation involves removal of the gun from its mount on the plane, cleaning, and minor repairs. The only tool required is the three-in-one spanner - wrench - screw - driver-punch. "Stripping" is a more detailed disassembly wherein the gun is completely taken apart and any worn components replaced. Out behind the hangar, two workers are aligning a fighter's guns. Occasionally they fire several bursts into a target mounted in a sand-filled, concrete-lined pit; then they make further adjustments. This precision business is definitely not a job for a cross-eyed armorer.

PRESENTLY you board one of the squadron's transport planes and take off for the air depot. "There are certainly a lot of men at work on your airdrome," you say.

"Yep, there are 133 alone charged with the maintenance of the pursuit squadron—28 planes. There are five master mechs and nine chief mechs, and 53 airplane and engine mechs of different ratings ranging from sixth class to first class. Then—let's see—there's a master air communications mech who has four radio mechs under him. There's seven armorers and two ordnance men, then there are three instrument technicians—still mechs to us—a like number of metal workers, an' seven radio operators. I'm the only first sergeant, and there's just one chief clerk. Under him there are seven or eight administrative clerks an' five technical clerks. But you know something? My specialists are those four cooks and stewards. You know they take regular courses in what they call their 'culinary arts'—which reminds me, are you hungry?"

"Not so much, just now," you probably say, "but tell me, who are those fellows who were washing the planes in the hangar?"

"Oh yes, there are 23 men, fairly recently enlisted, who are learning the ropes. They start out with the dirty work, and after they learn—or rather as they learn—they get jobs with more responsibility and also get higher ratings. I enlisted seven years ago, didn't know a carburetor from an aileron. After the second year they sent me to the Technical School at Rantoul, Illinois. When I came out I returned to the squadron as crew chief. Each chief, you know, is responsible for one or more planes to the engineering officer, who is a flier as well as a fine mech. Some of them are aeronautical engineers—smart boys."



Like the Army, Pan American checks fuselage for loose rivets

Before you realize it the big Douglas C-39 transport is settling to earth. Here at the air depot are bigger and better hangars; better, in that they are equipped with most of the gadgets and machinery found in an aircraft factory, even to the expensive machine tools—huge planers, millers, lathes, and grinders. Inside the hangar there are several craft in various stages of construction or destruction. The sergeant explains there are two classes of jobs done here at the depot: FWT rebuilding jobs, and the reclamation of wrecks. FWT, he says, means "fair, wear and tear," the wear due to normal service.

WHEN a plane has had a certain amount of use in a tactical squadron, the engineering officer asks the depot for permission to send the ship in for repair. When the ship arrives, it is immediately consigned to the supply officer and then stored in a "reception hangar" while a work order is issued to the engineering department. To help them decide whether the plane in question is to be repaired, rebuilt, or junked, the engineers consult a reclamation-loss table and a percentage table based upon the plane's service age (flying hours). If the estimated cost of repair is above a certain percentage of the plane's original cost, the ship is junked and parts are salvaged therefrom. Engines are put on trial in the same manner.

First, the ship is completely dismantled and parts are tagged for identification. The engine is removed and sent to the motor de-

partment. It may or may not be used on that particular ship again. Like the plane, the engine is taken down and all parts are cleaned with gasoline or some prepared solution. Cylinders are rebored, valves ground or reseated, new valve springs provided, the pistons fitted with new rings, cylinders painted, and new spark plugs and ignition wiring supplied. The crankshaft-connecting rod assembly is examined and, if necessary, parts are replaced. The magneto assembly,

Army planes periodically receive extensive examinations

carburetor, supercharger, all gears and their casings receive the same sort of scrutiny. Then the motor is reassembled and put on a test stand for "running in."

THE plane, meanwhile, is undergoing the same sort of piece-by-piece examination. Seats, instrument panel, gun mounts, controls, fuel and oil tanks, and other interior fittings are removed from the fuselage. All piping is replaced, as are control cables and the covering of control surfaces—if they are of fabric. The prop goes to the propeller department, wings and fuselage shell to the sheet metal section, instruments to their particular department for calibration. The landing gear is completely overhauled and oleo struts are given a re-fill. The plane is painted, by part, then reassembled. The engine and prop are fitted last of all. The plane, in certain respects, is actually better than new, the sergeant says. It is truly an amazing job, this rehabilitating of airplanes. After a thorough inspection, the ship is test-flown and then inspected all over again before it is delivered to the squadron from whence it came a month ago. Pursuits, attack planes, reconnaissance and training craft, bombers, and cargo ships are overhauled approximately seven times during their lifetime of peacetime service —fair, wear and tear. Wartime goings-on cut the plane's lives—excepting, possibly, the trainers and cargo craft—to from 30 to 60 days.

WHERE do the Army's "housekeepers" come from?

There are three sources of this valuable personnel: the Air Corps Technical Schools at Chanute Field, Rantoul, Illinois, Scott Field, Belleville, Illinois, and Lowry Field, Denver, Colorado; the 14 Army-supervised civilian schools training enlisted men; and the enlisted men who serve what is equivalent to an apprenticeship with a tactical squadron. The sergeant explains that the personnel he mentioned awhile back included only that for a full-strenth pursuit squadron. Bombardment squadrons, for example, require more trained specialists.

For every plane and pilot aloft, eight of these Air Corps "housekeepers" are required on the ground, when the base or airdrome is of permanent character; 12 are needed when the unit is housed on a temporary airdrome and there is much shifting about. One of America's biggest jobs is the training of these maintenance men.

Last, but far from least, is another variety of maintenance man whose fame is not at all commensurate with the importance of his work. A man who works with fatigued pilots rather than with fatigued metal—the flight surgeon. Airmen, too, undergo "line inspections" and "periodical checks," and they are often in need of "overhauls" of a sort. The Army's source of these none-too-plentiful specialists is the School of Aviation Medicine at Randolph Field, San Antonio, Texas. The flight surgeon's two immediate tasks are determining whether or not the aspirant is physically and psychologically fit for military flying, and keeping the pilot fit throughout his service hitch.

It is quite natural for us to think of the world's armies with wings in terms of thousands of aircraft, but planes don't make an air force; it takes men—and good men—down below to keep the warbirds in their element.

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SEALED

Swelling Rubber Retards Tank Leakage

OUR readers may remember a recent note on self-sealing tanks. The principle is simple; the rubber or other material, when pierced by a bullet, swells and prevents dangerous leakage. This idea was understood and applied nearly 20 years ago, then abandoned in American practice, and now it is revived, with all the pride warranted by a new discovery. While such pride is not altogether justified, it is perfectly true that the modern self-sealing tank is supremely efficient and adds but little to the weight of the tank. Our photograph shows one of these tanks, perfected by the United States Rubber Company, being installed in a Douglas bomber.—*A.K.*

Self-sealing

BROBDINGNAGIAN

Douglas B-19 Bomber Dwarfs All Planes

WHEN Colonel Lindbergh tells us that the Germans cannot invade the United States by air, he apparently forgets his own famous flight across the ocean and the fact that the range of the airplane is ever increasing. Thus the Douglas B-19 bomber, approaching completion as one of our photographs indicates, has a range under some conditions of more than 7500 miles, can carry a crew of ten men and 18 tons of bombs. If equipped as a troop transport, it can ferry 125 fully-armed men.

The B-19 is armed with machine guns and bombs, and is protected by armor in vital spots. Of course, to compensate for the huge range and pay load, there is some sacrifice in top speed, which is only 210 miles per hour. The fuel capacity is 11,000 gallons and the ceiling

Warbird B-19 overshadows the machines that made it grow

22,000 feet. The weight empty is 83,253 pounds, the gross weight varies between 140,000 and 164,000 pounds. The huge dimensions include a 212-foot wing spread, and a 132-foot fuselage length. The span of the horizontal stabilizer is 61 feet, which would have been considered a large span for the entire plane a few years back.

Power will be provided by four Wright-Duplex Cyclone two-row engines, each developing 2000 horsepower. Engineers and shop men encountered some strange problems in the design and construction of this giant. For example, the huge wing was built in a vertical position with the main fuselage in a great steel jig resembling ways in a shipyard. When the wing was finished, it had to be lifted by cables and turned to a horizontal position for splicing to the fuselage nose and tail sections. This was accomplished in a few hours, so painstaking had been the preliminary preparation.—*A. K.*

THE INSTITUTE MEETS

Brief Report on Aircraft Progress

The Institute of Aeronautical Sciences is now firmly established as one of the two leading aeronautical societies in the world, and its three-day technical sessions this year were attended by a large group of engineers. Space considerations, unfortunately, permit us to touch on only a few of the most important points of the meeting.

Washington is worrying the air transport companies a good deal. New transport planes cannot be built, engines intended for transport work have to be passed over for military purposes, pilots are called into military and naval air service. These steps may be necessary, but T. B. Wilson, Chairman of the Board of T.W.A. sounds a warning: "Even if commercial airlines were broken up or forced into temporary retirement at this critical stage when our national existence may depend upon our ability to achieve and maintain supremacy in the air, it is probable that we should have to rebuild an airtranport system to fulfill the need for a supply service as an auxiliary arm of our combat operations, which would be a wasteful and costly procedure." Another matter discussed in the Transport sessions was that of airplane feeder lines. C. Bedell Monro, of Pennsylvania-Central Airlines, gave excellent reasons for the expectation that there would come a network of feeder lines, operated with small airplanes at low cost, to supplement the main line services; the idea that air transport services can only be justified where great distances are involved is erroneous, in Mr. Monro's opinion.

Harold E. Morehouse, of Lycoming, told us what we might expect in the light plane engine: Muffing, better mounting, use of six cylinders instead of four, higher power, propellor reduction gearing, a cheap controllable-pitch propellor, and a cheap supercharger. A. R. Rogowski, of M.I.T., came to the conclusion that a two-cylinder engine, properly scavenged, with careful port design, would give the light plane the cheap, simple power plant which it requires today.

Thomas D. Perry, of Resinous Products and Chemical Company, set the record straight, on the matter of plastic planes, in his paper on Aircraft Plywood and Adhesives. The so-called plastic plane has been merely a revival of airplane construction in plywood, which, essayed during the World War, passed out because the casein or albumen or other glues employed were not sufficiently proof against weather effects and bacterial growths. Today the new synthetic resin glues are waterproof, temperature proof, and bacteria proof. Also, they permit the plywoods to be handled with great ease and rapidity in a new technique where heat and pressure combined allow plywood to be rapidly formed over a mould into a one- or two-piece fuselage, with elimination of rivets and other fastenings.

Rotary aircraft are forging ahead and two sessions of the meeting were devoted to this type. The art is advancing rapidly, with the new jump-off Autogiro perfected by Pitcairn, the Sikorsky helicopter, a new Kellett 'giro soon to be delivered to the Army, the Platt-LePage helicopter reaching completion. There are rumors that this summer the Army will match in a series of tests the performance of several rotary aircraft types against the performance of specially built, lightly loaded airplanes designed to fly at very low speeds when necessary.

Novelties in aerodynamics, recondite methods of structural analysis, flutter and vibration studies, and a dozen other topics were discussed, leaving the aeronautical engineers, profound technicians as they are, in a daze of mental indigestion.—*A. K.*

Inside the White Dwarf Stars

How an "Absurdity" Became a Discovery, Revealing a New State of Matter

HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

MORE than 30 years ago the writer of these lines was visiting the Harvard Observatory and talking with that wisest and kindest of astronomers, Professor Edward C. Pickering. The conversation had started with the fact that stars which were of small absolute brightness were always red—which showed that they were faint because they were cool, and shone feebly per unit of surface, and not primarily because they were small.

Nothing was known about the spectrum or color of one interesting star of this sort because it was close to a much brighter star, Omicron Eridani. When this point was raised, Pickering, very characteristically, said, "We may have this on our plates," and sent a message to Mrs. Fleming—an expert in the observation of spectra—asking to have the object looked up. Within a few hours the answer came: the star had been found on some plates, where it was not drowned out by its far brighter neighbor, and showed a spectrum of class A.

This meant, on the face of it, that we had to do with a body as hot as Sirius, and at least ten times brighter per square mile than the Sun. Its real brightness was known to be about 1/250 of the Sun's and it followed that the area of its surface must be less than 1/2500 of the Sun's, and its diameter less than 1/50 of the Sun's, or only about twice that of the Earth.

This was surprising, but a further deduction was alarming. This faint companion belonged to a binary pair and was known to have a mass at least 100,000 times that of the Earth. With this mass, and the diameter just estimated, the density of the star came out 70,000 times that of water, and more than 3000 times greater than that of any known substance!

Such a conclusion seemed absurd; and the narrator must have looked suddenly crestfallen at so incredible a result of the application of the "newer" physical theories which had previously been so successful. But Pickering, who had learned wisdom through a generation of following the progress of discovery, smiled benignly, and said: "It is just those discordances which lead to real advances in our knowledge."

He was absolutely right. At the moment of that conversation the puzzled youngster and the unruffled veteran were the only two human beings who had made the acquaintance of the white dwarf stars.

IT WAS sometime later when Eddington realized that the atoms inside a star must be stripped clean of all their outer electrons, which, under ordinary conditions, keep them from being crowded close together by high pressure, and hence that this ionized gas could be compressed to an immensely greater density than had previously been supposed to be possible. The "absurd" result of calculation then took its place as an intelligible physical fact. A new state of matter had been discovered by astronomical methods which could never have been produced in terrestrial laboratories. Pickering's prediction had come true.

This strange state was more fully understood after the fundamental laws governing atomic structure had been worked out. Among them was "Pauli's restriction" which stated that no two electrons in an atom could be alike in all the properties of their orbital motion, to use Bohr's older but more intelligible picture. R. H. Fowler showed that the same principles would apply, even if the electrons were torn free from the atoms and flying about freely in space. Within a given limited volume—say, a cubic centimeter—there can be only a certain number of electrons with less than a given speed of motion. More electrons can be put into the volume, but only on condition that they are faster-moving. The more electrons there are, the greater will be their average kinetic energy. This energy is curiously different from that of the ordinary motion of the molecules of a gas. The latter depends on the temperature; at the absolute zero the motions would (theoretically) cease. But the former type of motion cannot be stopped at all, so long as the electrons remain densely crowded. The gas of which they are constituents may be heated. This puts in additional energy of motion, which could be got out again by letting it cool. But no cooling could take out the "zero-point energy" demanded by the quantum laws.

These motions would obviously tend to make the electron-gas expand in all directions. Could it be confined by walls, a heavy pressure would be required to hold it in, and it would still exert this pressure, even if all possible heat could be removed from it. To put in ordinary heat would increase the pressure, but by only a small fraction.

Our assumed mass of gas could not, of course, be composed entirely of electrons, on account of their powerful electrostatic repulsion for one another. But a sufficient number of positively charged nuclei to neutralize these forces could be present without affecting the argument.

All this sounds like the most abstract sort of physics; but it soon becomes astronomy when we apply it to a large mass of matter held together by its own gravitation. When we write down the expressions for the gravitational pressure inside the mass, and for the relation between pressure and density in the "degenerate" state, we have enough to work out the whole structure of the body. Its central density is six times the mean density. Its size depends on its mass—and everything about it can be calculated if we know this and one thing more. This is the average mass per electron, and depends on the composition of the material. For hydrogen, with mass 1, and one electron to be separated, this average is 1. For helium (mass 4, 2 electrons) it is 2, for oxygen (mass 16, 8 electrons) it is still 2. For heavy elements it is slightly greater—for iron it is 56/26, or 2.15, but the

great difference is between hydrogen and everything else.

Given the mass of a body, and the amount of hydrogen in it, we can then work out, on pure theory, the size and density which it would have if, having lost all of its available energy of every sort by radiation into space, it settled down "fixed in an eternal state" of quantum-degeneracy.

For a given mass, the calculated radius comes out greater and the density smaller, the more hydrogen is assumed to be present. The companion of Sirius has 98 percent of the Sun's mass. This quantity of hydrogen in the degenerate state would form a sphere 1/26 the diameter of the Sun. The diameter of an equal mass containing no hydrogen would be 1/125 of the Sun's.

The actual diameter of the star—estimated from its luminosity and spectrum—lies between the two values, and the same is true for θ Eridani B—the only other white dwarf for which we know the mass.

This suggests very strongly that the white dwarfs are very nearly in the degenerate state. They cannot actually be so, for they shine, and are still getting rid of heat; but they may be of nearly the same size.

To settle this decisively, we must answer two hard questions. First, what difference in the internal structure of the star will there be if, in addition to the zero-point energy locked up in the quantized motions, there is a moderate percentage of additional energy available as heat? Second, there must be an atmosphere of ordinary gas at the surface, and a gradual change to degeneracy in the interior. How deep is the layer in which this change takes place?

Dr. Marshak, of the University of Rochester, has recently answered both of these questions in a paper which forms a main part of the work for which he and Professor Bethe recently received the A. Cressy Morrison Prize of the New York Academy of Sciences.

Study of the conditions in the outer layers of a white dwarf demands a knowledge of the physical behavior of a gas during the transition from its ordinary state to complete degeneracy. Dr. Marshak has solved this very difficult physical problem, derived the relation between the pressure, temperature, and density of the partly degenerate gas, and determined the rate at which heat will flow through it under a given temperature gradient.

Armed with this equipment, he has calculated, starting with the known values of gravity, temperature, and outward heat-flow at the surface of the companion of Sirius, how the pressure, temperature, and density increase with depth. Twenty-five miles down, the density comes out twice that of water, the temperature 1,900,000 degrees, and the pressure 100,000,000 atmospheres, but the gas is not yet degenerate. At 10 times the depth, the density is 5000 times that of water, the temperature almost 10,000,000 degrees, and degeneracy is practically complete.

Similar calculations show that, for the known white dwarfs, the surface-layer of partly degenerate gas will at most be two or three hundred miles thick. Their diameters are of the order of 10,000 miles or more, and hence the main bodies of these stars must be composed of completely degenerate gas.

The temperature at the bottom of the outer transition layer is of the order of 10,000,000 degrees. Carrying his calculations inward, Marshak finds a central temperature of 15,000,000 degrees for Sirius B, and 30,000,000 for θ Eridani B. These are high values, but a simple calculation shows that the internal energy which is "frozen" and prevented from escaping by the quantum restrictions would correspond to a temperature of several hundred million degrees.

Comparing such an actual star with one which had cooled down and ceased to shine, we find that, for the same mass, the two bodies are of very nearly the same size and density, differing by less than one percent. But the visible stars are as hot inside as ordinary stars, like the Sun.

This raises a new problem. Inside the Sun, the collisions between atomic nuclei cause a gradual transformation of hydrogen into helium, which supplies the energy which they radiate. These atomic encounters should be more numerous inside a white dwarf, in proportion to the density. With the same internal temperature we should expect thousands of times more heat to be produced than in the Sun, and yet the amount actually produced cannot be greater than that which the star radiates—less than 1 percent of the Sun's output.

Here is a discrepancy of 1,000,000 to one, or more. The only way to explain it appears to be to assume that the atoms which, by their reactions, produce heat within the Sun, are enormously less abundant in the white dwarfs. This result could be reached by diminishing the percentage of hydrogen a million-fold, or that of carbon and nitrogen in the same proportion, or of both by a thousand-fold, or in other obvious ways.

But the transmutation process, as Bethe has shown, consumes hydrogen alone—remaking the carbon and nitrogen atoms to be used afresh. It appears, therefore, very probable that there is no hydrogen inside a white dwarf—or, at least, not more than one part in approximately 10,000,000.

If there is no hydrogen in a degenerate mass, its size and density can be computed. When the calculation is made, the results for θ Eridani B agree satisfactorily with those derived from its brightness and spectrum. There is still hydrogen on the outside of this star—its lines are conspicuous. But the process of diffusion inward must be so slow that it could remain there for a very long while, even if it were exhausted in the interior. But for the companion of Sirius, things look bad. The calculated diameter is only 1/125 of the Sun's, while the observed "Einstein shift" of the spectral lines, as well as the brightness, indicate that the diameter is not far from three times this. There seems to be only one escape from the difficulty—to assume that Sirius B is a close double star, and that both of them are white dwarfs. The individual components, being less massive, would be larger, when in the degenerate state, give more light (for the same temperature), and show a smaller Einstein shift. In this way, theory and observation may be brought into agreement. There is something not wholly satisfactory about what Kuiper (who suggested it) calls an *ad hoc* hypothesis. But it is entirely reasonable. There are plenty of double stars. Many components of visual binaries are close spectroscopic pairs. We have no *a priori* reason for supposing that there is such a case in the system of Sirius, but there is good reason *a posteriori*. As Sherlock Holmes once remarked "It is an old maxim of mine that, when you have excluded the impossible, whatever remains, however improbable, must be the truth."—*Princeton University Observatory, February 4, 1941*

Our Next Source of Oil

Petroleum Geologists are Turning from the Structural Trap to the Stratigraphic Trap

RANDALL WRIGHT

IF WE examine the resources of petroleum in the United States we see that we have within our borders more oil than all the rest of the world put together—so much that if no more wells were drilled we could go on supplying ourselves and part of the outside world at the present rate of consumption for 15 years. While we consume more than a billion barrels of oil annually, as each new year rolls around more new reserves have been found than have been used.

Why, then, are so many wells being drilled? Simply because oil is becoming harder to find. Drilling for new oil fields arises from the necessity of protecting immense investments in refineries, pipelines, and marketing facilities. The oil fields are being depleted. For example, some of the wells in the new Illinois areas begin by yielding several thousand barrels per day, but before they are a month old they give only 100 barrels or less daily. In 1939, as many as 2589 exploratory, or "wildcat" wells were drilled. Less than 10 percent of these found oil. While an excess of new oil, over current consumption, was discovered, nevertheless this excess is not as great as in previous years.

If the present trend were to continue it might mean shortage of oil some time in the future. Probably, however, that trend will not continue for very long. Exploration for new oil is today in a transition stage—a transition in its objective from the structural trap type of underground reservoir to the stratigraphic trap.

In the earlier years of his search for oil, the petroleum geologist did not work blindly but had a kind of pattern to follow. In the latter part of the previous century he learned from I. C. White, the noted geologist, that oil would be found in a given locality, provided a certain set of conditions pre-existed. These conditions, a typical example of which is shown in Figure 1, are as follows: There must be a "sand" (a sandstone), porous and permeable, to hold the oil. There must be an impervious stratum—generally a bed of shale or limestone—overlying the sand, to seal in the oil. Previously there must have occurred some special process, not yet clearly defined, which drove the oil out of the mother-of-petroleum beds and into the sand reservoir. And, finally, the pattern required earth movements which had made a structural trap, either the conventional anticlinal fold or a dome in the form of an enormous overturned bowl. The oil, because it was lighter than underground water, gathered in the highest part and could not escape. The geologist mapped the anticline and if all the necessary conditions were present, the drill found a new oil field.

This was the pattern which the oil geologists of two generations followed, with enormous success. By 1930, however, most of these

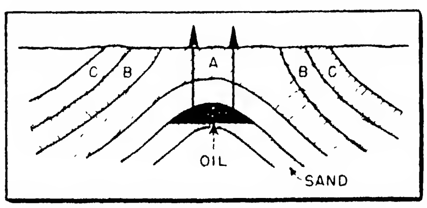

Figure 1: **Showing how oil sometimes gathers under the apex of a structural fold, because it is lighter than the ground water. A, B, and C are impervious strata. Such oil sources—anticlines—have long been exploited**

structures which could easily be mapped on the earth's surface had been drilled, and if the petroleum geologist had stopped there, we would now be facing the prospect of gasoline rationing. But the geologist knew that there were other anticlines so deeply buried as to be hidden at the surface by strata deposited after the anticlines were folded (Figure 2). He therefore diverted to economic ends some instruments previously known only to abstract science and used them as probes to explore what he could not see. The instruments he borrowed from physical science were the seismograph, torsion balance, magnetometer, and others. In the past decade, during which these geophysical aids have been in large-scale use, many new oil fields have been discovered. These geophysical procedures are indirect, not direct, methods of locating oil. That is, they do not point to oil as such, but only help the geologist to find situations where oil is most likely to be found. They make use of the differences in the characters of rocks. For example, the seismograph reveals differences in density in the rocks encountered by arti-

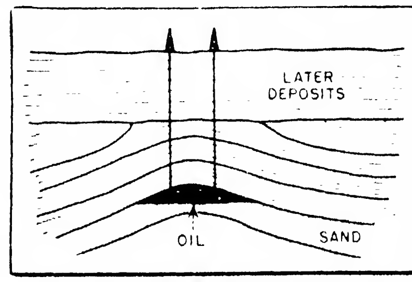

Figure 2: **But anticlines that are hidden like this by later rocks are hard to find by normal methods, may easily be missed**

ficial earthquake waves created at the surface by dynamite. These waves travel downward and are reflected upward again by hard layers. Time differences required for the round trip of these waves at different points show the direction of slant of the sub-surface beds, and thus lead to prognostications as to the presence or absence of an otherwise hidden anticline. This anticline then may — or may not — be found to contain oil.

TODAY, however, these methods are approaching the same impasse which confronted the surface geologist of a decade ago — most of the structures that were easy to locate by geophysical methods have now been found and drilled. Therefore, if structural traps were the only kind of petroleum reservoirs on earth, the future might be melancholy. Happily, there exists another class of oil reservoirs — the stratigraphic traps — and it is these which are at present assuming increasing importance. Moreover, since the events which led to their formation were more common in earth history than the events which made structures of the kind already described, probably the oil available in strati-

graphic traps will be found even more abundantly than it was in the structural traps (anticlines).

Large amounts of oil now are being produced from stratigraphic traps in Oklahoma, Kansas, Texas, and California—perhaps 10 percent of the whole. Long ago, some of these formed as beaches along ancient seacoasts, like the one to be described below. Others formed in other ways. A great many of them have been discovered by accident, a few by study.

A TYPICAL stratigraphic trap — there are several kinds — may be understood by looking first at the sandy beach along the present-day ocean. The sand grains are seen to be evenly sized and cleanly washed by waves and tides, and therefore the mass is porous and permeable. Now imagine this land and seascape buried, as it may be after millions of years, under thousands of feet of mud bed and hardened into shale, coal beds, limestone, and sandstone layers. Imagine also that you are standing on top of this pile of rocks over the ancient beach, and that you are an oil man and you intend to drill for oil. To find fame and fortune, you have only to guess exactly where this elongated former beach strip lies beneath you. Here the seismograph or magnetometer cannot assist you, because there is no differential of density or hardness or magnetism — the basic princi-

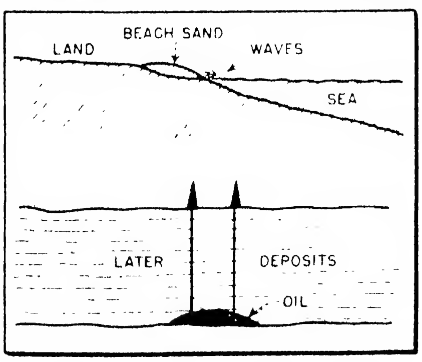

***Figure 3:* The buried beach reservoir type of stratigraphic trap, showing (above) how it is formed and (below) how it may later become an oil storage**

ples on which these instruments work — to make the sand reveal itself. What would you do? What, today, is the petroleum geologist doing?

Examples of stratigraphic traps are shown in Figures 3, 4, and 5. In Figure 3, at the top, is shown the cross-section of a beach, a land surface, and the adjacent sea as they actually existed in the Pennsylvanian Period, some 300,000,000 years ago. The action of waves and tides had then formed a beach sand which was porous like a modern strand. The lower drawing shows the same features covered with thousands of feet of later deposits which have obscured the details. Oil, migrating from its sources of formation elsewhere, has become concentrated in the sand, which is now a permeable sandstone reservoir, and has been discovered by the drill — as in the Bartlesville and Burbank "shoestring" trends of Kansas and Oklahoma. To reveal the subsurface details of such an oil sand is beyond the scope of geophysics. Here the geologist has to use his wits and imagination, proceeding from lines of evidence based on observation of a number of things. Some of these appear at first rather obscure and perhaps not helpful. He has to picture in his mind, from close study of the

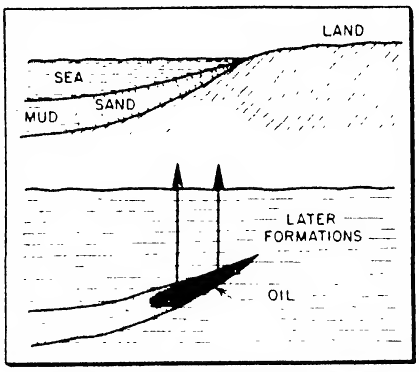

***Figure 4:* The lenticular sand body type of stratigraphic trap. Above is the ancient condition and below the modern one in the same place, hiding the oil**

ancient sand grains and tiny fossils, the landscape of a geologically remote time. What he finds repays the tedious work, for he is learning how to locate the stratigraphic traps.

In Figure 4, the upper drawing shows a lens or tapered layer of sand as it was being deposited in geologically ancient times, close to shore on a sea-bottom. The lower sketch shows the trap as it is today, covered with a thick blanket of later formations. The approach to the problem of discovering this type of trap again seems at first to be roundabout; it is made through study of the location of ancient oceans.

A third type of stratigraphic trap (Figure 5) began to form long ago, as sand and mud beds were deposited flat on the floor of an ancient ocean. Later the deposits hardened and were warped, tilted, and uplifted from the sea. Erosion planed the beds off at an angle; then the sea again invaded, younger beds were deposited, and the trap shown was thus completed, to be discovered now by resourceful geological deduction connected with a study of mountain-making

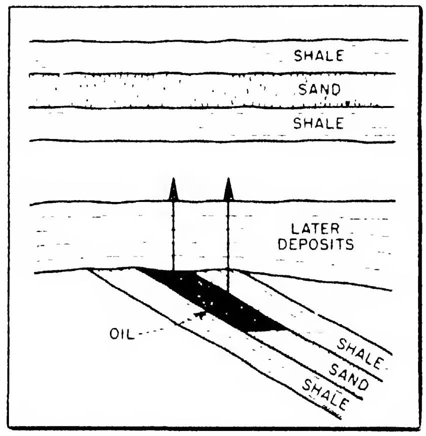

***Figure 5:* Overlap type of stratigraphic trap. Original geologic condition is shown above, while the modern and much altered condition is illustrated below**

movements. Some of the largest wells in the world produce from this type of trap reservoir.

The problem of finding stratigraphic traps is essentially a new problem. It involves close study of the events of geologic history. Since the geologist cannot locate them directly, he begins on a broader quest, seeking a clear understanding of conditions in past epochs. This requires new methods of work and the study of new concepts; these still are being evolved. More and more study will be given to this type of oil accumulation before geologists acquire facility in discovering stratigraphic traps.

THE geologist in this newer quest of oil is reading earth history through his microscope as he examines fossils of tiny organisms, such as forimanifera, ostracods, diatoms, and others, because these fossils reveal changes in the ancient conditions from one stratum to another. They also distinguish by their nature whether the beds in which they are found were shallow or deep sea deposits — some organisms prefer one, some the other. Thus these microfossils are used by the oil geologist as keys to the age and sequence of the beds of rock, as found both at the surface and in samples brought

up from deep drilled wells. Thanks to his training, details noted in closely studied samples of shale, sandstone, and limestone permit him to read the events of the ancient lands — the types of erosion, steepness of the hills long since gone, the size and swiftness of former rivers. From the coarseness of grain, its evenness, color, and type of cement, and from other observed evidences, he deduces how far from shore the deposits were formed and, on the basis of this and kindred knowledge of stratigraphy — a part of the stock-in-trade of the schooled geologist—he is constantly learning how to locate hidden stratigraphic traps, our next great source of oil.

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LOST RING

Physicist Squeezes Ring Out of Copper

DISCOVERY that the musical ring can be squeezed out of copper and then pounded back into it suggests a clue to why some materials are hard and others soft.

Dr. Thomas A. Read, Westinghouse Research Fellow, reported the discovery before the American Physical Society. He illustrated the discovery by gently tapping a bar of copper cast from molten metal. It rang as clearly as a tuning fork, but after it had been squeezed in a press, or even just dropped on a table, it answered with a dull "clunk" when tapped with a hammer. Yet when the copper bar was pounded or cold-worked thoroughly, its lost ring returned. [See article "Plastic Metals," Scientific American, November, 1940, pages 262-264. — *Ed.*]

While no one is yet sure why the metal loses its ability to ring and then regains it, Dr. Read said, the most likely explanation is that dislocated copper atoms stifle the ring.

"If given a chance," he said, "the atoms of copper will arrange themselves on perfect rows and layers as they cool slowly from the molten state or during a careful heat treatment of a solid piece of the metal. Then they all 'join hands' in an ideal latticework and when they are struck they vibrate in unison, thus giving off a musical ring. But when this latticework is jarred by dropping or squeezing, some of the atoms are pushed out of place. These disturbed places can move about, absorbing the musical vibrations."

Dr. Read has been studying copper's elusive ring in the hope that his findings may ultimately help improve alloys.

"FOSSIL LIGHTNING"

An Odd Tube of Fused Sand May be a Fulgurite

A 23-FOOT specimen of "fossil lightning," known as a fulgurite, has been placed on display in the Rosenwald Geological Museum of the University of Chicago. It was discovered by Dr. George S. Monk, assistant professor of physics at the University.

Fulgurite is formed when lightning strikes into siliceous sand, such as is found in sand dunes. The heat from the huge electric spark causes the sand particles to melt and fuse into a long, snaky tube composed of a dark gray substance similar to glass. The tube represents the path taken by the lightning as it arcs through the sand, and refutes the popular misconception that lightning has sharp jagged edges.

Cemented remnants of fulgurite on display in a 23-foot panel

Dr. Monk discovered the Rosenwald Museum specimen when walking through the sand-dune region of Ludington State Park, in Michigan. He noticed a piece of dark rope-like substance which he recognized immediately as fulgurite and mentioned his discovery to a party of University of Chicago geological students who were making a field trip through the region.

Bits of "fossil lightning"

Previous finds had been fragmentary. Dr. Monk turned down an offer from the group to probe the spot because the specimen would be of little value if the pieces became scattered among a number of individuals. Accordingly, he arose at five o'clock the following morning, returned to the site of his discovery, and in several hours recovered all the fragments. He removed his shirt, formed it into an improvised bag, and carried away more than 40 pieces of fulgurite, gathered over a radius of 50 feet.

At the University the fragments were cemented together by Dr. Paul Miller, curator of the Museum, and are now on display as a permanent exhibit.

SOAP

Electron Microscope Looks at Twisted Fibers in Cleansers

WITH the aid of an electron microscope, scientists have seen with their eyes into the mystery casually referred to as soap. Soap is revealed as consisting of bundles of fibers, some of them twisted, reports Dr. J. W. McBain, Stanford University professor of chemistry.

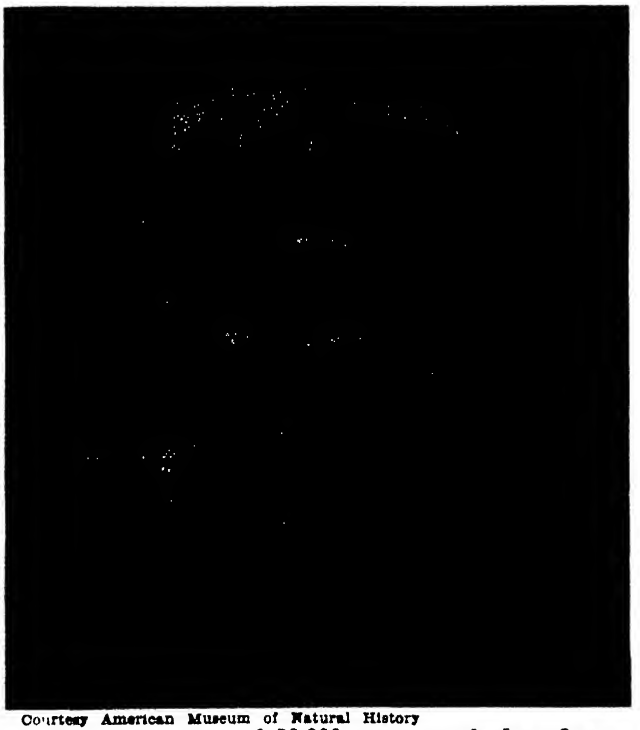
The possibility that soap may be photographed in even greater minuteness is foreseen, as the next step toward solving soap secrets. Scientists admit that they still do not know just what happens chemically when you wash your hands with soap. Dr. McBain believes that when the physical structure of soap is understood, it will be easier to understand the problem of soap and dirt.—*Science Service.*

Evolution in the Future

Where is Our Human Species Headed? Will Man Pull Himself Together and Go Ahead?

HENRY M. LEWIS, JR.

SINCE the dawn of reason, few questions have so stirred man's imagination and given rise to such varied and diversified speculation as that having reference to the ultimate result of the human evolutionary process. Are the most highly developed specimens of our present civilization the final chapter in the history of human development, or are we merely a step in the ultimate evolution of a race of super-men?



Courtesy American Museum of Natural History

Cro-magnon man of 20,000 years ago had as fine a brain and skull as we have in 1941, but he lacked written methods of storing up facts to enhance his brain leverage. Earlier man's brain was poorer

In the light of present trends, it seems probable that our physical and intellectual development is slowing down, while social evolution, on the other hand, is moving at a brisk pace with the rational organization of society—its goal—as yet unattained.

Evolution, in one sense of the word, may be regarded as a response of the living organism to its physical environment. Throughout all history, changes in this physical environment have necessitated and brought about changes of an evolutionary nature in the animal kingdom. Periods of colder climate necessitated the growth of heavier coats of hair to protect animals from death by freezing. Shortage of one kind of food or another brought about necessary changes of teeth and digestive apparatus, rendering them adaptable to new foods under new conditions of life.

In the case of modern man, however, the physical environment has far less evolutionary force than in the rest of the animal kingdom. Through his intellectual development, man has risen above a dependence upon evolutionary factors to preserve him through a changing physical environment. The circumstances of modern civilization have eliminated the necessity for physical alteration and visceral and structural adaptations to meet the needs of environmental change. In cold climates, man need but use heavier clothing as he pleases. Shortage of one kind of food does not compel him to undergo changes of teeth and stomach in order to adapt himself to the use of other foods; he still knows how to continue producing food of the kind he long has eaten, or else can so alter and modify new kinds of food that the old digestive system can take care of them. In this respect, then, to the extent that physical evolution depends upon a changing physical environment, man now is largely removed from the forces of evolution, since he can control his environment.

Furthermore, natural selection, or the survival of the fittest, considered by many scientific authorities to be the greatest of all the directing forces in physical evolution, has lost much of its meaning in civilized society, and consequently is without much effect. By the most extraordinary means, governmental institutions protect and preserve the feeble-minded, the insane, and the anti-social, as evidenced by our well established state schools, asylums, and prison systems. Public agencies—local, state, and national in character—function to protect the physically weak and deformed from what otherwise would be dominance by more powerful forces. We are just beginning to realize that intelligent human selection must take the place of natural selection, and that the most unfit must be prevented from perpetuating their kind. It is evident, though, that the most that can be expected from such artificial selection is that mankind as a whole shall approach somewhat nearer to the level of the best individuals of the past and present. Unfortunately, the opposition which is brought to bear against this train of thought by religious agencies and teachings makes the task a difficult one. The possibility therefore, of such intelligent artificial selection becoming a reality in the immediate future is exceedingly remote when viewed in the light of a sentimentality which is peculiar to modern man and contrary to Nature.

In these circumstances, the conception of unlimited evolutionary progress among men has become more or less unpromising. In every line of progress, a limit is sooner or later reached beyond which it is not possible to go. Further progress, if it occurs at all, must be in other directions. For at least 100 centuries, there has been no notable progress in the evolution of the human body. This indicates that apparently the limits of physical evolution already have been reached, at least among the most perfect specimens of mankind. However, we are told by those who believe in an endless progress that 10,000 years is entirely too brief a

time in which to look for marked evolutionary advance, and we are cautioned to remember that evolution is slow and that time is long. But, after all, the time available for progressive alteration is not infinite, and 10,000 years, representing 300 or 400 human generations, should be long enough to reveal the direction of any marked tendency in evolution.

When we consider the fact that in every line of evolution, progress is most rapid at first and then slows down until it stops, it becomes difficult to avoid the suspicion that, in those lines in which human evolution has gone farthest and fastest, it has practically come to an end. At least we can say that there is no prospect that the hand, the eye, or the brain of man will ever be much more complex or perfect that it is at present. It is, of course, possible that the brain may undergo further evolution in the future, just as it is possible that the elephant may evolve a longer trunk or the giraffe a longer neck, but the size of the human brain has not increased since the time of Cro-magnon man, approximately 20,000 years ago, and the great prevalence of nervous disorders among the most highly intelligent classes of the present day may be taken to indicate that the nervous system already has developed to a point where it is getting out of balance with the other vital functions. In every line of progressive evolution there comes a time when specialization can go no further without interfering with the harmonious interrelation of parts and thus breaking down co-operation.

In most respects man is a generalized rather than a highly specialized type of vertebrate. This is shown by his hands, feet, limbs, teeth, digestive system, and sense organs, and, insofar as these animal functions are concerned, present tendencies in human evolution seem in the main to be making for a simpler and still more generalized organism. This is shown in the simplification of many organs and systems, the progressive degeneration of certain parts, and the presence of many rudimentary structures. This combination of a highly specialized brain with other organs of a more generalized type has been of the greatest advantage in human evolution, for it has made possible at the same time unequalled intelligence and remarkable plasticity and adaptability of bodily functions. From the evolutionary point of view, perhaps the most perfect type of man would be one in which the brain had reached the highest possible stage of differentiation and in which the rest of the body remained in a relatively generalized condition.

By eugenics and euthenics—that is, by mate selection and environmental control—the general level of physical development of man may be improved, just as it has been in many domestic animals. Many diseases may be eliminated and immunity to others may be increased, feeble-bodiedness and feeble-mindedness may disappear and the race as a whole may be made more hardy. There are, however, no indications that future man will be much more perfect in body than the most perfect individuals of the present, or than the most perfect specimens of a century or so ago.

No one can doubt that there has been a remarkable development of intellect throughout the long course of past evolution. In the case of man there is abundant evidence that there has been growth of intelligence from the earliest to the latest types, and that this development has gone further in some races than in others. Furthermore, there is considerable evidence that even in the most intelligent races and individuals there is still much room for intellectual growth. When we consider the great mass of irrational and emotional mankind, we cannot but be impressed with the thought that the race as a whole is just emerging from unreason, and that instinct and emotion still are the masters of our lives and beings.

The fact that there is room for improvement by no means signifies, however, that the improvement will take place. Just as in the case of physical evolution, so here also there are limits beyond which intellectual evolution apparently cannot go, and these limits are far short of ideal perfection. The record of the intellectual development of mankind during the historic period may seem to refute this conclusion, and to prove that, even if men are not growing more perfect physically, they are growing more perfect intellectually, since we certainly know more things than the ancients did.

It is necessary, however, to distinguish between knowledge and intellect—between things known and the capacity for knowing. By means of language, tradition, and writing, the experiences of past generations can be handed on to present and future ones, and thus each generation may receive the knowledge accumulated throughout the past. In this sense we are the heirs of all the ages. Our store

When glacial climes chilled temperate regions, elephants there grew hair. Mastodon, as painted by the scientific artist Charles R. Knight for the Ernest R. Graham Hall, Field Museum of Natural History, Chicago

of knowledge is growing, but is our intellectual capacity increasing? Does anyone think that the past 2000 or 3000 years have yielded an increase in human intellect remotely comparable with the concurrent increase in knowledge? Do the best minds of today excel the minds of Socrates and Plato and Aristotle? On the contrary, it is the opinion of some who have studied the subject that no modern race of men is the superior—possibly none is the equal—intellectually, of the ancient Greeks. Even in the most distant future, there may never appear greater geniuses than Archimedes or Plato, or of Shakespeare, Galileo, Newton, Darwin, or Einstein. Undoubtedly, eugenics and education can do much to raise the intellectual level of the general mass but it probably cannot create a new order of intellect.

The brain has its limits even as a storehouse, and it necessarily follows that, with knowledge continually increasing but intellectual capacity remaining constant, each individual mind can take in only a small portion of the sum of human knowledge. Therefore, in this age, intellectual specialization is necessary. Progress in intellectual evolution, no less than in physical, lies in the direction of increasing specialization and co-operation. This progress is no longer taking place within the individual but rather in the specialization and co-operation of many individuals. It is as if we added one and one and one, and obtained not three, but more. The intellectual evolution of the individual has in all probability virtually come to an end, but the intellectual evolution of groups of individuals is only at its beginning.

If the evolution of the human individual has come to an end, certainly the evolution of human society has not. In social evolution a new path of progress has been found, the end of which it is difficult to foresee. Evolution has progressed from one-celled organisms to many-celled, from small and simple organisms to larger and more complex ones. By the union of individuals into families, tribes, and nations, still larger and more complex units have been formed, until now, by intelligent human co-operation, we have political units which include millions of men, and there is the possibility that, profiting by costly lessons we are learning at this minute, we may be on the eve of bringing together into some intelligent form of league or federation all the peoples of the earth. Possibly future historians may record that super-civilization began with the end of wars and the co-operation of all the peoples of the earth. At least, there is every evidence that human culture still is advancing and that the end of this advance is not yet in sight.

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Electricity Catches Trout

Science of Fisheries Research is Aided by Data Obtained With New Electric Shocker

DUCK DORMIN

What happens to all the trout that are planted in our streams? How many survive and finally nestle comfortably in the bottom of the creel as a result of a perfectly cast Quill Gordon? What size fish should be planted for the best results: fry, fingerlings, or legals? What is the subsequent mortality of these various size groups? What time of the year should fish be planted? Do spring plantings bring more tight lines, or do fall plantings make the disciples of Walton happier? Could better fishing be maintained by distributing small numbers of fish throughout the year?

Answers to these and dozens of other questions along similar lines would be of great value to fish culturists. Faced with a constantly increasing demand for more fish in the trout streams of the country, brought about by the rapidly growing number of sportsmen who seek the wily trout, these fish culturists are developing the science of fisheries research. This form of scientific approach to the pressing problem of fresh-water fish conservation is still in its swaddling clothes but unmistakable signs indicate that the infant is growing into a lusty youth. One tonic which has been administered might be termed "electric therapy;" it employs a device know as the "electric shocker" which temporarily stuns a fish so that it can be readily caught, examined, and returned to the water without harm either to the fish, its natural habitant, or the workers who engage in the operation.

The generating apparatus is like the conventional lighting outfit used by farmers and at summer cottages and consists of a 110 or 220 volt, 60-cycle, alternating-current generator. A maximum output of 500 watts is sufficient for work in our eastern trout streams. The generator is driven by a small gasoline engine, the two units being attached to a portable mounting.

One of the terminals of the generator is grounded by connecting it to an iron pipe driven into the stream bed near the shore; the other terminal of the generator is connected by an insulated, flexible wire to a strip of wire screening four to six inches wide and 10 to 15 feet long. A wooden handle is fastened to each end of the screen and large seine-corks are attached so that the screen will float on the surface of the water.

Power from portable generator helps remove undesirable species from trout habitations

When the electric shocker is in use, the screen is stretched across the stream and two operators move it up and down the test area of the stream which is blocked off with nets. A third man retrieves the stunned fish and the fourth

The electrified screen in use in a section of a trout stream

member of the crew unwinds the wire connected to the screen.

As in all electrical work, there is some shock hazard. Work of this kind should only be done by experienced operators who should wear rubber boots and rubber gloves and who have a clear understanding of the fact that a little water in the right—or wrong—place will permit the current to pass through their bodies instead of through the ground-to-wire-screen circuit. At the best the result may be an unpleasant shock; at worst, it may be fatal to the operator.

The conventional method of making a fish population census is by seining, but snags and boulders often render this method difficult or impossible. The electric shocker, on the other hand, is approximately 90 percent efficient even in locations where seining is out of the question.

In conjunction with controlled plantings of marked fish, the electric shocker makes it possible to remove the fish from sections of a stream at frequent intervals to determine the biological capacity of the stream, survival ratio, growth rate, the success of stocking at different seasons, the condition of the fish after being placed in a stream, the incidence of parasites, and innumerable other factors which are important in modern management of fisheries.

Previously, experiments with tagged fish depended upon that fickle entity—fishermen's luck. It was necessary to wait until the end of the fishing season to evaluate data. Now, any section of a stream can be selected and most of the fish brought forth for examination in the comparatively short time of a few hours. Best of all, the electric shocker does not affect the insect life of a stream. Food awaits the fish that are returned to a stream.

Another important use of the electric shocker is the control of undesirable species. Carp and perch have ruined many trout waters. Heretofore their removal has been hampered by inefficient methods. The success of preliminary experiments in this sort of fish control with the electric shocker indicates great hope for its extensive use in the future.

Thus the electric shocker takes much of the guesswork out of fish-culture practices. Results can be tested at frequent intervals. Already the shocker has pointed the way to a more scientific approach to fisheries research.

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FROZEN FOOD PACK

For Liquids, Vegetables, Fruits, Solids

A new container has been announced by Container Corporation of America, which combines a Cry-O-Vac latex bag (product of Dewey & Almy Chemical Co.) and a solid fiber or paperboard case for bulk packing frozen liquids such as fruit juices; semi-liquids, such as cracked eggs and syrup pack fruits; and also bulk solids such as peas, beans, and berries, in units of from 10 to 50 pounds.

The latex bag is held open for filling by stretching it over a fiberboard collar, rectangular in shape. After filling, an air-tight seal is effected by twisting the collar three or four times. This closure is maintained, and the collar prevented from untwisting by its relation to the side walls of the rectangular outer container. After defrosting, the bag is readily untwisted by the consumer, and the opening through the collar again provides a convenient means of unloading the bag.

The Cry-O-Vac bag, tough and flexible at low temperatures, is said to be sufficiently elastic to prevent any danger of bursting as a result of expansion during freezing, thus eliminating the need of the usual head space to allow for expansion and the consequent undesirable presence of air in contact with the foods.

A somewhat different use of the same principles is the OJ container for orange juice and other liquids. After filling, the latex bag is heat sealed to one end of the carton against a round opening in the inner flap. Upon thawing, the perforated outer flap is removed and the latex bag is punctured through the opening for greater ease in pouring the contents.—*India Rubber World.*

WATTAGE

Economy in Lighting the Home

It is more economical to buy one light bulb of high wattage than several bulbs of low wattage, according to lighting experts of the United States Department of Agriculture. Not only is the initial cost less, but one bulb of high wattage actually supplies more light than several small ones that total up to the same wattage.

For instance: one 100-watt bulb costs 15 cents while four 25-watt bulbs cost 40 cents. The cost of operation is the same for both. But it would take six 25-watt bulbs to furnish the same amount of illumination as one 100-watt bulb.

It is important to check voltage as well as wattage when buying light bulbs. Figures for both are clearly marked on the end of each bulb. If a bulb is made for a lower voltage than the house current, it will burn out more quickly. If it is for a higher voltage, it will not give the normal amount of light. Most households have 115-volt

electric systems. It is easy to check the voltage to be specified when buying bulbs by calling the electrical service supply agency.

Since a coating of dust on an electric bulb reduces its efficiency, it should be cleaned occasionally. The safest way to do this is to remove the bulb from the socket and wipe it with a damp cloth. Never let the bulb soak in water or allow the base to become wet.

PLANT FOOD

All Requirements in One Concentrate

PLANT chemistry, a comparatively recent science, has made tremendous strides in the last few years. Among the early results predicted by research workers in this field was the development of really efficient plant nutrients and chemical fertilizers, one of which is now announced by William H. Rorer, a Philadelphia pharmaceutical manufacturer, under the trade name of Plant Dinner.

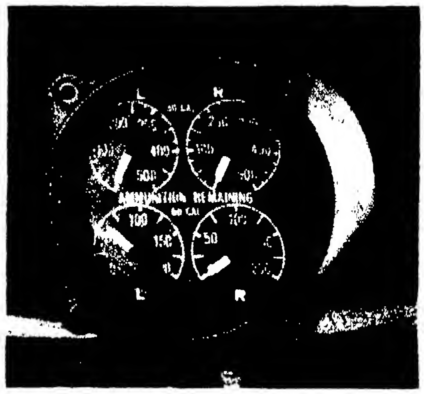
This compound is a chemical concentrate, prepared in powder form, which, it is claimed, contains all the discovered inorganic chemical elements necessary for plant nutriment, as well as the organic substances which the plant itself manufactures but which accelerate growth markedly when administered externally. The plant food includes not only combining forms of nitrogen, phosphorous, and potash, long familiar as fertilizing agents, but also the trace ingredients now recognized as equally important — copper, zinc, iron, boron, sulfur, calcium, magnesium, manganese, and ammonium. It contains, in addition to Vitamin B_1, four other vitamins beneficial to plant health, including the newly discovered Filtrate Factor which has shown striking results when applied in the correct proportions. Also present in Plant Dinner are the two best known and most thoroughly tested growth hormones, napthaleneacetic acid and indolebutyric acid.

Extremely simple to use, Plant Dinner dissolves almost instantly into complete solution. It saves labor by combining plant feeding with regular watering periods, the highly concentrated chemicals providing 128 gallons of regular solution for every pound of the product. Extensive tests by a number of agricultural college technicians, professional growers, and well known amateurs, have established definite and convincing results. Treated grass shows 65 percent average superiority over untreated areas of equal size, yielding more than one and one-half the amount of grass from the same amount of seed and producing seven-inch roots compared to four and one-half inch roots. Flowers are stated to demonstrate an average of 45 percent improvement when treated. Vegetables respond with as high as 50 percent greater yield of normal healthy plants.

The product is also efficacious and commercially practical for speeding the rooting of cuttings, forcing plants to completion before frost, keeping fruits on trees until ripe and preventing loss from dropping, seed germination in hot beds and seed flats, indoor and outdoor transplanting, and other greenhouse, conservatory, and agricultural problems.

AMMUNITION COUNTER

A NEW application of direct-current Selsyn control is found in the dials, illustrated on this page, which indicate to military pilots how many



Air-fighter's indicator

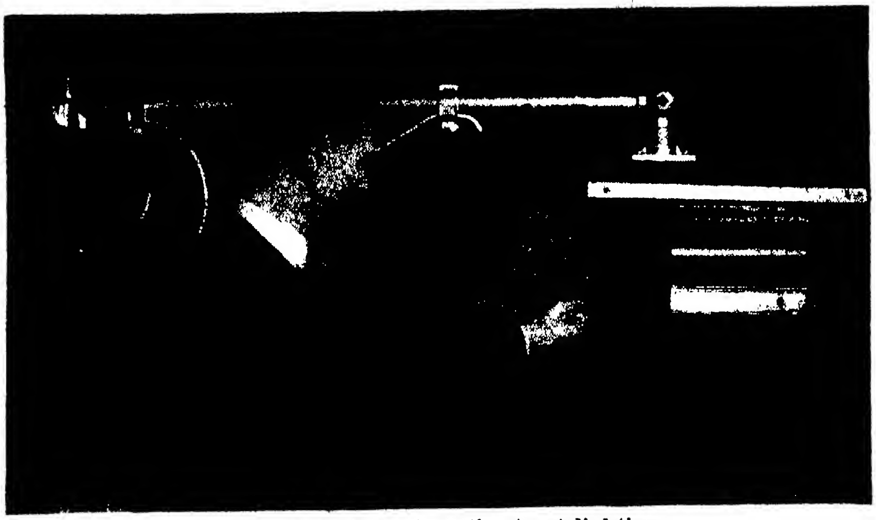
rounds of ammunition remain in their machine guns. Designed by General Electric Company engineers, these dials can be placed directly in front of the pilot regardless of the location of the guns on the ship or their distance from the cockpit.

BARBED-WIRE

British Torpedo Destroys Broad Entanglements

A REPORT published in *The Illustrated London News* gives details of the so-called Bangalore torpedo, designed by an inventive member of the Royal Engineers at Bangalore. It is stated that this new torpedo is especially effective in blowing openings in barbed-wire entanglements to provide passage-

Test results of new plant food described. *Above:* Poinsettias after transplanting. One at right was watered with plain water, center one with nutrient lacking hormones and vitamins, and one at left with Plant Dinner. *Right:* Lawn grass in which left-hand section was watered with the new plant food and right-hand section depended on rain water



Equipment for automatic street lighting

way for troops and mechanized units. The torpedo was used with great effect by the Australians at Bardia.

A series of tubes, apparently some four inches in diameter, constitutes the torpedo. Each tube, packed with explosive, has a pointed nose and hollow cone at the base, into which fits the nose of the next section, and so on to the length desired. The first man dashes forward, carrying the first section of the torpedo, which is pushed through the wire along the ground, and is followed by the next man, whose job is to fit the nose of his section into the base of the first, the jointed tube being then pushed forward. This sapper falls back and takes up a covering position on the flank while the next advances, until the length is decided for the operation. The detonator is attached to the rear and is fired by a fuse or electric wire, the party being retired slightly out of the immediate area of explosion. The torpedo utterly disintegrates the obstruction, blowing a wide opening through which the infantry can then rush the defenses.

AUTOMATIC LIGHT

Street Light That Turns Itself On and Off

LATEST contribution to safer streets and highways is this new sodium street lamp designed by General Electric engineers and equipped with a photo-electric cell which will turn it on and off automatically as needed.

The photo tube is built into the rear of the unit and has a small glass window through which light can pass. This tube is set to respond to a predetermined level of natural lighting which is considered sufficient for safe travel. When the natural light falls below that level, as at dusk, the tube operates a control which turns on the sodium lamp. At dawn, when natural light returns to a safe level, the control turns off the lamp. A time delay feature prevents faulty operation which might be caused by lightning flashes or by headlights of automobiles or trains shining on the photo tube.

The lamp itself is a 10,000-lumen type particularly adapted for isolated installations such as at railroad crossings, highway intersections, and underpasses.

WELDED DWELLING

High-Speed Construction of New Georgia Home

NEW building construction speed, which permits erection of factories, plants, homes, and other structures in half the time of conventional methods, and which has definite implications in speeding present defense building requirements, is recorded in completion of a new seven-room residence in Georgia in less than two months.

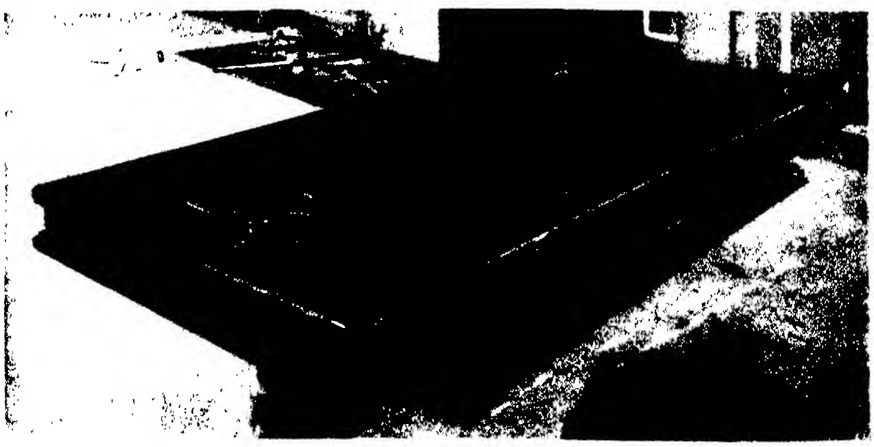
This home, built for Mr. and Mrs. R. G. LeTourneau, utilizes a new type of prefabricated arc welded steel "building block," or panel, which completely eliminates the usual framework. Applicable to any structure, this "building block" is framework and wall member in one unit, reduces building construction time up to 50 percent.

These steel "building blocks" are 7 feet 8 inches long by 3 feet 10 inches wide by 6 inches thick for walls and 18 inches for roof. Panels are formed by pressure stamping of 12-gage steel sheets, which are welded together with interior spacers set at intervals of not more than 24 inches to form a stout, box-like double panel member. In home construction, these panels completely eliminate conventional stud and joist framework; in larger structures, they do away with columns and roof beams. Because they are field welded together by continuous welds, both inside and out, they form unusually rigid and fireproof construction. They can be welded together to suit any design or arrangement. Modern shielded arc welding equipment, manufactured by The Lincoln Electric Company of Cleveland, Ohio, is used.

CHEMICALS FOR TREES

Can Retard or Force Blossom Formation

AN EXTRACT of last year's dead leaves will delay the opening of next year's buds on cut fruit-tree twigs set in it, Prof. C. G. Vinson, of the University of Missouri, reported recently. A contrary effect on peach twigs, forcing the flower-



A building block of welded steel

ing at an earlier date, was obtained with several organic acids commonly found in plant tissues—succinic, maleic, fumaric, and malic. Tannic acid had an effect similar to that of the dead-leaf extract, hindering flower opening.

The experiments reported by Prof. Vinson are preliminary steps in a search for a compound that can be sprayed on dormant fruit trees in early spring, to prevent them from blossoming too early and then getting caught by frost, at present a source of great losses in northern orchard regions.—*Science Service.*

PRESS

For Transfer Work, Offset, and Color Printing

A NEWLY patented portable press for use in a wide variety of printing processes has recently been announced. Called the Laszlo Universal Press, its features include a resilient hard-rubber cylinder which lends itself to offset printing, eliminating the necessity of rubber blankets. It is also provided with two interchangeable printing beds, one a flatbed for printing from unmounted metal, celluloid film, paper plates, and so on, the other a chase for type-high material, mounted cuts, rubber and linoleum plates and the like.

This new press is of wide interest to schools, photographers, artists, and small printing plants. Because of its versatility it can be used as an etching or lithography press, for making reproductions from photographs, for squeegee operations, or for printing lithographs and making color reproductions.

In operation, the press is clamped to the corner of a table. The motion is imparted by a three-spoke star wheel, while a pair of strong metal frames holds the upper hard-rubber roller and the lower steel roller. The drawing bed, or printing board, has a bevel edge which moves back and forth between the two rolls. Roller bearings are provided for easy operation.

TENDER "FRANKS"

Pineapple Juice "Predigests" the Skins

IT HAS been discovered that the fresh juice of pineapples, when properly applied to natural frankfurt casings, makes them more tender. By means of the new process, these casings become as tender as the ground, cured smoked, and cooked meats which they contain.

This process was developed in

A bath in pineapple juice renders "frank" skins more tender

food laboratories of Swift and Company. According to Dr. R. C. Newton, who supervised the experiments, many months of exacting research were required to perfect the new process, patents for which are pending.

"It has long been known that pineapples are particularly rich in protelytic enzymes, which have an effect on proteins," Dr. Newton explains. "It remained, however, for exhaustive tests made in the laboratory to apply these enzymes to natural casings. Further experimentation was necessary to develop the process on a manufacturing scale and this was achieved by the laboratory and operating departments."

The enzymes referred to are a peculiar kind of protein found in some vegetable, fruit, or animal cells, which have the ability to act on other organic materials, "peptizing" the proteins and thereby softening the cell tissues.

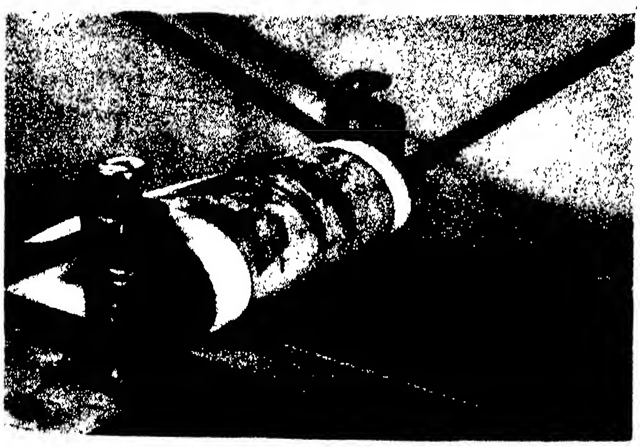
In production, the frankfurts are given a bath in a pineapple juice solution immediately after the natural casings are filled with the meat, or the links of sausage may be sprayed with a fine mist of the same solution. After the frankfurts are allowed to hang for a sufficient time to permit the enzymes to do their work, the regular processing of smoking in special ovens over hardwood fires is continued. This smoking and the following steps of cooking, cooling, and washing with sprays of water remove all traces of the juice and its enzymes. The traditional flavor of the sausage remains without even the slightest taste of the pineapple juice.

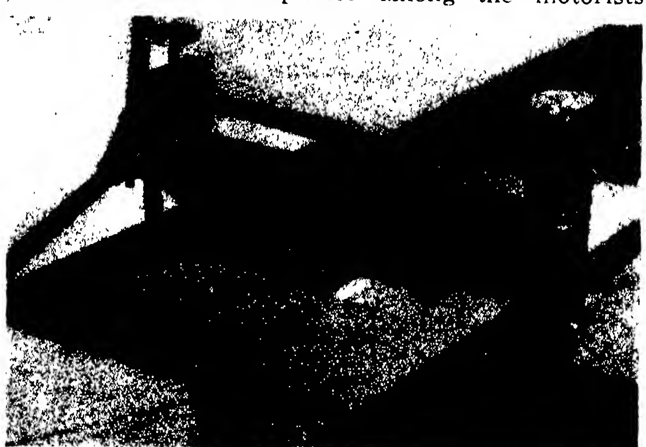
RUBBER FENDERS

Reduce Motor Vehicle Upkeep Costs

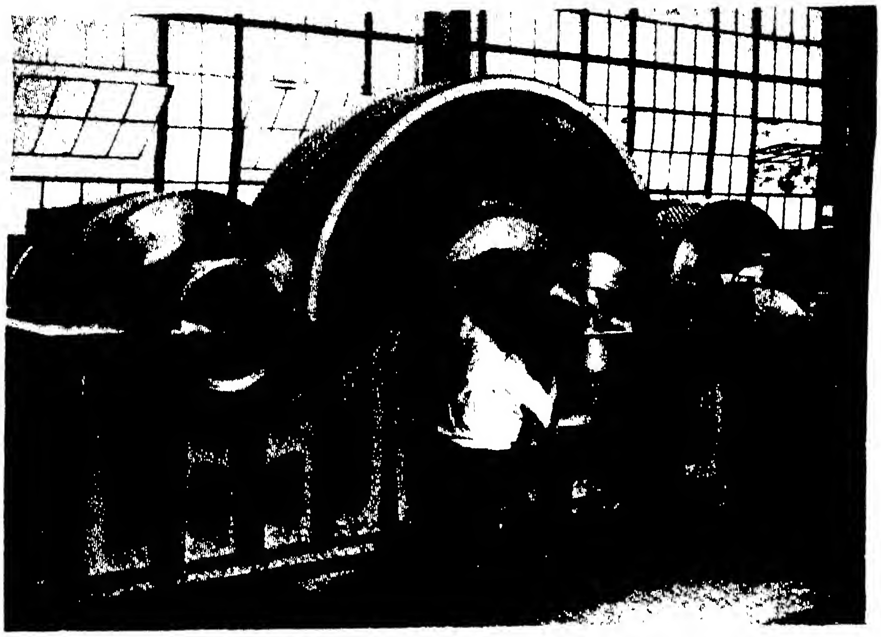
THE fenders of automobiles being among the most vulnerable parts of a vehicle, the Dunlop Company of England some time ago decided to investigate the possibility of replacing metal with rubber in the manufacture of fenders for commercial vehicles.

The original Dunlop rubber fenders met with overwhelming acceptance among the motorists





This versatile press will handle a wide variety of printing surfaces



Checking the main bearing seat of a huge Diesel propulsion gear

of England and today, reports *Highway Research Abstracts*, thousands of passenger and commercial vehicles in England are fitted with these rubber fenders.

The fenders are molded in one piece and by the careful compounding of the rubber are made sufficiently rigid without impairing flexibility.

Many collisions which would damage metal fenders have no effect on the rubber type and they immediately recover their shape after impact. Furthermore, the rubber is waterproof and rustless.

Economy of rubber fenders is evident from the fact that they greatly reduce the cost of replacing or repairing damaged fenders, plus the saving of the time consumed for such repair work.

DIESEL GEARS

Largest Twin Engine

Propulsion Gear

TWIN Diesel engines, each rated at 4250 horsepower, will drive the propeller shafts of four of the type C-3 Maritime Commission vessels. The reduction gearing through which these engines will operate is shown in one of our photographs; the engineers in the picture are checking the main bearing seat of the unit.

Since the Diesels used in these particular installations operate at a normal speed of 180 revolutions per minute, it is necessary to introduce a reduction gear in order to drive the propeller at the predetermined rate of 85 revolutions per minute.

By means of electric couplings in the propulsion gear drives, it is possible to operate the ship with either engine while the other is shut down. This will, in emergencies, permit adjustments to be made on the engines at sea, while the vessel is proceeding under the power of the other. Maneuvering is also simplified since one engine can be run in the forward direction, while the other can be run in reverse. The engineer can thus move his ship forward or astern by the operation of a single lever controlling the electric couplings.

The propulsion gear drive illustrated is being built by Westinghouse Electric and Manufacturing Company. Among other Diesel gear drives being produced by this organization are ones for type C-1 vessels for the Maritime Commission. These units, smaller than that shown, are rated at 4000 continuous shaft horsepower, and will also incorporate the electric coupling system.

HEINKEL BOMBER

More Details of the Plane

Shown on Page 198

FROM S. W. Clatworthy, artist, of London, England, comes the drawing reproduced as the frontispiece of this issue, together with the following data regarding this plane that can carry a load of eight 550-pound bombs.

"In raids on Britain," writes Mr. Clatworthy in a letter to the editor of this magazine, "this type, Germany's standard long-range bomber, so predominated, especially at night, that raiders were being termed 'Heinkels,' just as they were called 'Gothas' in the last war after the fighter-bomber makeshift so widely used by Germany.

"Less ugly than most German bombers," continues Mr. Clatworthy, "the Heinkel still has the typical hog-backed, sagged-tail look. Crew is normally four, span 74 feet, all-metal construction, top speed 274 miles an hour, ceiling 26,000 feet, can manage about 2000 miles with two tons of bombs. Defense armament, as usual with German bombers, is woefully weak. The three machine guns are on crude mounts that allow only restricted cones of fire

"Detail design of these Heinkels is involved, especially in the petrol injection system that replaces carbureters to handle the inferior 87-octane fuel. The undercart action, clearly shown in the drawing, is another typical instance. There is evidence of quick mass-production standardization in the wings, where the same bracing piece is merely multiplied for additional local strength, a negation of true design which must carry the penalty of reduced performance"

LARGEST CAR FERRY

Is Also Safest, One

Of Fastest in World

RADICALLY different in appearance and construction from previous ships of her type, the all-steel *City of Midland* is the largest, most modern, and one of the fastest car fer-

Over she goes!

ries in the world. It was launched last fall from the yards of the Manitowoc Shipbuilding Company, and will go into service in the Lake Michigan fleet of the Pere Marquette Railway Company. The *City of Midland* has an over-

all length of 406 feet, a displacement of 8200 tons, and a service speed of 18 miles per hour, reports the *Du Pont Magazine*. Special construction features which make her one of the safest ships afloat include: division of the reinforced double-waterbottom hull by steel bulkheads into 11 water-tight compartments; all-steel, fireproof construction; all-metal furniture; automatic sprinkler protection and fire-alarm system; signalling, communication, and lifeboat facilities; gyroscope and radio compasses; direction finder. When completed, she will cost $2,000,000.

DENOUNCED

Astrology Lacks All Scientific Foundation

ASTROLOGY, the tenets of which hold that the stars and planets exert an influence on human events by which predictions may be made in advance, is denounced as lacking every conceivable scientific foundation as well as being psychologically harmful, in a report issued by the Boston and Cambridge Branch of the American Association of Scientific Workers, according to *Science Service*.

The report was prepared by a committee of which Dr. Bart J. Bok, associate professor of astronomy, Harvard University, is chairman, and Mrs. Margaret W. Mayall, research associate of the Harvard Observatory, is secretary. Methods and claims of the astrologers are briefly summarized, and reasons given why they are not accepted by scientists.

"Astrologers have not provided us with as much as a sound hypothesis that might serve as a basis for their speculations," states the report. "Astrologers attempt to offset this lack of a sound working hypothesis by the introduction of terms and concepts that are unknown to physicists and astronomers.

"Scientists would feel justified in considering astrology as a legitimate field of scientific inquiry," continues the report, "if astrologers could claim that its basic rules had been established through a rigorous study of correlations. This is not the case. The rules by which astrologers interpret their horoscopes have not been derived from any known experiments or observations."

Though no careful, extended, statistical study of the success or

failure of astrological predictions, which might prove a decisive test, is known ever to have been made, statistical tests of the supposed broad influences of the planets and zodiacal signs have failed to verify these claims, the report declares.

GARDEN HOSE

50-Foot Length Weighs Only Eight Pounds

A DISTINCTLY new type of garden hose is featured by its extreme light weight. A child can handle a 50-foot length with ease, since the

50 feet—eight pounds

total weight, including coupling, is only eight pounds.

Although the "Junior Garden Club," announced by The B. F. Goodrich Company, is designed for many specialized services, where the regular size may be cumbersome, such as watering flowers, supplying sprinklers, washing the car, cleaning basement floors and other uses, it carries from 65 to 75 percent as much water as the conventional size, at average pressure, when attached to spray nozzle or sprinkler.

Inside diameter of the hose is 3/8 inches, while the standard inside diameter is 5/8 inches. The hose, however, is equipped with full size couplings, to fit all standard bibs.

WOOD PLASTIC

Treatment Opens New Fields for Wood Products

IN OUR January 1940 issue we published a report on a new method of plasticizing wood. More details of this method have been announced by the Forest Products Laboratory, Madison, Wisconsin. Comparatively simple in operation and reasonably inexpensive, this plasticizing proc-

ess has apparent application in the bending of wood and in the production of cheap plastics for molded products. The treatment is a by-product of the laboratory's research on the chemical seasoning of refractory woods.

During the course of seasoning experiments it was found that oak which had been soaked in a concentrated solution of urea and then dried became plastic and capable of being bent, twisted, and compressed when a temperature of approximately 212 degrees, Fahrenheit, was reached and while the wood was still in the dry condition. The wood retained its plasticity while at or above the critical temperature and resumed its normal hardness and rigidity when cooled, retaining its altered shape unless reheated. In addition, it was found that urea-impregnated wood chips or sawdust when subjected to elevated temperatures and pressures can be compressed to a density approaching that of basic wood fiber, and that in becoming self-bonding with the urea-lignin produced by the treatment, they form a material of true thermoplastic properties.

Although the new process apparently has wide possible application in wood bending and in the production of cheap plastics, the Forest Products Laboratory has so far been obliged to ignore specific applications and concentrate its available research effort on exploring fundamentals of the treatment. The work was initiated with blackjack, overcup, southern red and white oaks, but trials with such woods as Sitka spruce and juniper have indicated that the treatment should be applicable to softwoods as well as hardwoods.

Thermoplasticity, as produced in wood by the urea treatment, should be useful in the molding of a variety of wooden articles, including those produced by molding large plywood sheets.

HIGHBROWS?

The Highbrow Hasn't a High Brow

MYTHS of "Nordic superiority" fare ill at the hands of Dr. Ales Hrdlicka, eminent physical anthropologist of the Smithsonian Institution, who has just completed a study of the heads of 150 of America's leading scientists. Far from being long-headed blonds, Dr. Hrdlicka's group of outstanding American

scientists tend to be wide-headed, and their hair is decidedly dark.

The group included in the study were chosen from the membership of the National Academy of Sciences. This body, sometimes referred to as the Senate of American science, elects to its membership only persons of proved accomplishment and reputation in the various fields of science.

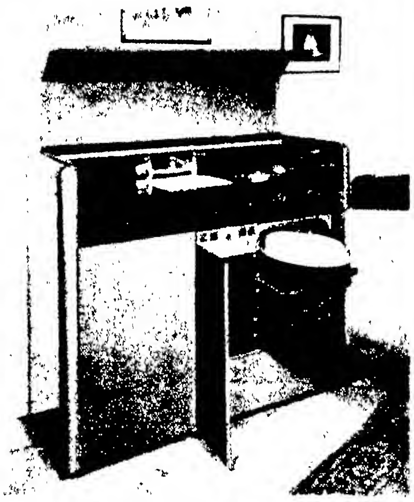
Another myth that suffers from this study is that of the "highbrow." Eminent scientists don't average more prominent foreheads than do other men, the measurements show. Neither do scientific leaders have massive heads on stoop-shouldered, spindling bodies; the general physique of Dr. Hrdlicka's 150 is full-grown and sturdy. This, it is pointed out, is largely a matter of nutrition. Men with their brains and training get good jobs and keep them.

Seven percent of the group have decidedly back-sloping foreheads—another traditional "sure sign" of inferior intellect. This, Dr. Hrdlicka explains, has nothing to do with the brain content of the skull. A sloping forehead is usually due to larger-than-ordinary sinuses over the eyebrows, giving a wider base rather than a narrower top. Even when the slope is due to other causes, however, it does not necessarily mean any inferiority of the brain.—*Science Service.*

CABINET KITCHEN

Combines Sink, Stove, And Refrigerator

A NEW cabinet kitchen, produced by Dwyer Products Corporation, may well be installed in the living room of a home where, in its closed position, it would appear to be a



Cabinet kitchen, open

private bar or a large radio cabinet. In reality, it is a combination refrigerator, electric stove, and kitchen sink. It is intended, of course, for use in small apartments or other places where space is at a premium.

As shown in our pictures, the upper lid opens to expose the small

Cabinet kitchen, closed

kitchen sink with a work top to the left and two electric hot plates to the right. Below, a door to the left opens into an electric refrigerator. The right-hand door opens to show an oven sufficiently large for roasting average-size birds.

BOAT FITTINGS

Of Monel, They Are Light Weight

SOMETHING new in fittings for the masts of small sailing craft, especially racing classes, was dis-

Light but strong boat fittings

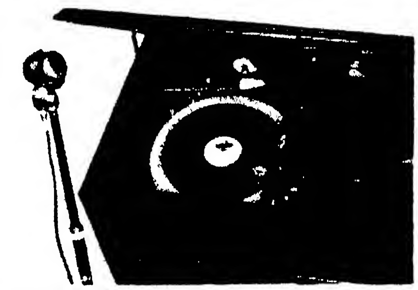
played at this year's Motor Boat Show in New York City. The fittings were developed in connection with the trend toward fittings lighter than those which can be provided in conventional cast forms.

The fittings are made of 20 gage, cold-rolled, Monel strip with a breaking strength of 120,000 pounds a square inch. Their weight is approximately one-third that of cast fittings. They were designed by Whitney Stueck, naval architect.

RECORD PLAYER

For Recording and High Quality Reproduction

FAST-GROWING interest in high-quality recording and reproduction of records for transcription in the home has created a demand for a turntable that will meet these requirements. Such a unit has just been announced by the Presto Recording Corporation. It consists of



Professional tone for amateurs

a dual-speed, 12-inch turntable of a type formerly available only in commercial recorders.

This new turntable is made up of an aluminum casting that has been precision machined to dynamic balance. It revolves on a single ball bearing at the base of a bronze shaft well. A metal pulley on the motor shaft drives against a rubber tire fitted directly on the rim of the table, thus eliminating idler wheels and other wearing parts. A slip-over pulley is provided so that the turntable can be operated at speeds of 78 and 33 1/3 revolutions per minute.

The manufacturers claim that each part of this turntable unit is hand-fitted and finished. Speed accuracy is placed at 0.4 percent and speed regulation at 0.2 percent.

The entire motor and turntable unit, shown in one of our illustrations, is mounted on a steel base ready for installation in portable or console phonographs.

(Continued from page 208)

synthetic material created from polyvinyl chloride, which is derived by a series of chemical reactions from coke, limestone, and salt.

The new paint is liquid at room temperatures and requires no heating before application. At ordinary temperatures it can be either brushed or sprayed, and can be thinned with either brush or spray thinners when necessary. It is made only in semi-glossy black and must be used in conjunction with a Koroseal primer with similar characteristics.

The new paint, when thoroughly dry, is extremely resistant to the action of fumes and vapors from acids, alkalies, and salts at room temperatures or slightly above. It resists all acids except concentrated formic and acetic, and is not affected by brass, chrome, nickel, cadmium, zinc, copper, silver, or tin plating solutions. Such solutions are not contaminated or fouled by the thoroughly dried paint, although it is not recommended for constant immersion in liquids.

REFRIGERATED METAL

Process Prevents Premature Age-Hardening

In die pressing duralumin sheets for aircraft body paneling, bottle-necking has hindered production. Sheets must be pressed within one to two hours after solution treatment because those allowed to age-harden longer give excessive splitting and consequent loss in scrap. High cost limits the number of presses in a shop, and an efficient management must plan production from the various dies to keep the presses operating as much of the time as possible.

To increase press efficiency by eliminating delays from waiting for freshly heat-treated blanks, J. C. Arrowsmith and K. J. B. Wolfe, Pressed Steel Co., Ltd., have reported to the Institute of Metals experiments on the storage of heat-treated blanks at subnormal temperatures, as has been done for some time with duralumin rivets, to inhibit premature age-hardening.

Temperatures of −6 degrees to −10 degrees, Centigrade, were found the most useful and economical for storage of heat-treated blanks. The time for material to harden to about 90, the Vickers penetration number at which pressing begins to be difficult, is then around 100 hours. It can safely be assumed that no appreciable age-hardening occurs in the initial 50 hours of storage.

Because of its low cost, paraffin was selected for the liquid in the quenching bath following the normalizing operation. Film remaining on the blanks helps to spread the lubricant used in the subsequent pressing. Where presence of paraffin is undesirable, industrial methylated spirit or white spirit may be substituted.

A refrigerator has been installed immediately outside the salt bath shop in the aircraft department of the Pressed Steel Co. Rapid transfer to the refrigerator and the quench into refrigerated paraffin are important factors in obtaining maximum delay in age-hardening.

Experience with the refrigerator in actual practice shows increased press efficiency, reduced scrap, and necessity for fewer heat-treatment furnaces. Output of the heat-treatment department has been raised by the more regular flow of work and the fact that heat treatment of blanks can proceed regardless of fluctuating demand from the press shop.—*News Edition*, American Chemical Society.

SPINNING BALL

Spins 110,000 Times a Second

The propeller of a pursuit airplane, spinning at 2500 revolutions per minute, is practically standing still compared with a tiny steel ball used in experiments described by L. E. MacHattie, of the University of Virginia, reports *Science Service*.

By magnetically suspending a steel ball 3/32 of an inch in diameter in a vacuum, so that friction was nearly eliminated, he was able to spin it 110,000 times per second, about 2600 times more rapidly than the propeller.

In some researches, a rapidly rotating mirror is needed. To test the feasibility of such a use of the device, two flat faces were ground on the ball. Then it was spun to more than 100,000 revolutions per second without bursting. In another test a drill rod 3/16 of an inch in diameter and 7/8 of an inch long, was spun at 36,000 revolutions per second, before it was bent double.

An important use of rapid rota-

tion is in the possible separation from ordinary uranium of the power-producing U-235. The different forms of the elements, or isotopes, can be separated with a spinning device called an ultracentrifuge, which works fundamentally like the cream separators used on farms. Though relatively slow rotary speeds such as 66,000 revolutions per minute have been estimated as necessary for the uranium separation, the cylinder must be several inches in diameter, which makes much more of a problem than the tiny ball.

The leader in this research is Dr. J. W. Beams, also of the University of Virginia.

SLOTTING HEAD

Precision Unit for Milling Machines

A universal slotting head that can be used on all types of milling machines for precision work has a ram stroke adjustable from 0 to 4 inches; the adjustment may be quickly and accurately accomplished. The head is equipped with a ¼ horsepower motor with four

Sharp corners, special shapes . .

speed changes — the speeds range from 50 to 250 or from 100 to 580 strokes per minute. The tool holder —of the clapper-box type — can be turned in any position desired.

The housing of this universal slotter, announced by The Experimental Tool and Die Company, is polished cast aluminum, and all working parts are made of graphitic steel, heat treated and ground. Preloaded Timken bearings are used throughout and the gears are hardened and ground.

It can be used for cutting keyways, templets, splines, internal gears and for slotting out precision blanking dies or wherever sharp corners and special shapes must be machined.

GLASS INSULATION

Plus Varnish for Electrical Equipment

Glass cloth, impregnated and coated with heat resisting varnishes developed especially for this purpose, is now available for use as insulation by manufacturers of electric motors, generators, and similar equipment. This new insulation material, known as Irvington Varnished Fiberglas, is furnished in full-width rolls and tape of various widths and thicknesses.

The material consists of a woven glass cloth base (Owens-Corning Fiberglas) impregnated and coated with a special varnish which greatly increases its resistance to abrasion and impact, and increases its overall mechanical strength The resulting material has much higher insulation resistance and much greater ability to withstand heat than other flexible insulations, thus making possible manufacture of lighter, smaller motors for any given horsepower rating and safer operation of these motors under continued overloads.

NEW RAYON

Exhibits Characteristics of Wool

A new rayon fiber, with a high degree of permanent crimp, has been developed by the Rayon Department of the Du Pont company Lacking as yet a more formal title, it is known by its laboratory designation of "Fiber D." Tests indicate that fabrics containing Fiber D possesses certain characteristics now available only in wool. The crimp, which gives bulk and loft to the yarns and the wool-like appearance and feel to the fabrics, is an inherent characteristic; if it is partially removed during processing, it may be recovered by simple treatments. An outstanding characteristic is a smooth cross-section, as contrasted to the crenulated or ridged pattern of standard rayons. It is claimed that fabrics made of

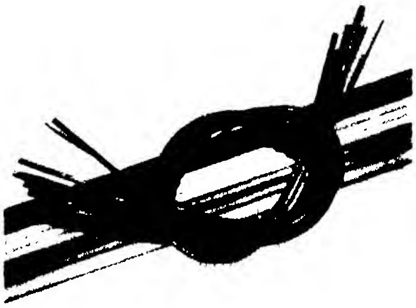
it are able to shed dirt more effectively. As with other rayons, Fiber D may be dyed to brilliant clear colors even in the lightest shades.

VARNISHED TUBING

High in Strength, Extremely Flexible

A NEW electrical insulating tubing, designed for use by manufacturers of electrical, radio, and instrument equipment, is varnished on the inside as well as the outside surface.

Known as Ire-O-Volt Varnished Inside-and-Out Tubing, the new



Varnished—inside and out

product meets all A.S.T.M. specifications for an oleoresinous varnished product. An oleoresinous varnish is an oil-base varnish as distinguished from spirit soluble varnish or lacquer.

Principal advantages to the user include greater ease of slipping over wires due to the smooth varnished inside surface, and high tensile strength with extreme flexibility. It possesses maximum heat endurance when subjected to A.S.T.M. test at 425 to 450 degrees, Fahrenheit, for 15 minutes and is slow burning. Moisture resistance and ageing properties are said to be superior to those obtainable with tubing varnished on outside only.

FIRE RESISTANT

Paint for Wood Retards Spread of Fire

FOR SEVERAL years the United States Forest Service has been conducting experiments with fire-resistant paints. Of these, the Service now reports that the most satisfactory are those made with linseed oil and finely ground borax. Pigments may be added to provide desirable brushing qualities and to furnish hiding power.

In the manufacture of this paint the borax is ground in a pebble mill and screened through a 200-mesh sieve. Then two parts of the powdered borax by weight are mixed with one part of raw linseed oil and thoroughly ground. This paste is then mixed with color, turpentine, and drier just before using.

Experimental work thus far is proving satisfactory although it will take some time to develop fully the advantages and limitations.

GLASS FABRIC

THE airplane has a way of pressing into its service every branch of applied science and every new material. Also, the needs of the flying machine have a way of bringing new methods or materials into being. Thus, while linen or cotton fabric for the wings and fuselage is an excellent covering material, it has certain drawbacks, and we learn that wings covered with glass cloth have been flown on the light Taylorcraft plane. The glass cloth, developed by the Owens-Corning Fiberglas Corporation, is held to be ideal for aviation use. It does not shrink or stretch in the presence of moisture, does not rot, and is not affected by temperature changes. The glass cloth is non-absorbent, smooth, and continuous, and does not soak up moisture in rain or fog, which is an important matter from the point of view of weight.—*A. K.*

ALUMINUM FOIL

Protects Bacon, Keeps it Fresh

A NEW packaging method keeps bacon fresh in color and taste for periods up to six months or more, thereby making it possible to ship bacon over long distances and store it until sold. The package consists of a flat aluminum foil envelop with a Pliofilm lining, developed by the Reynolds Metals Company. It is designed to hold 12 half-pound packages of sliced bacon. After the meat has been placed within the container, carbon dioxide is directed into the envelop for approximately 12 seconds, after which the package is tightly sealed.

The aluminum foil exterior of the envelop protects the meat from exposure to the light, thereby preventing rancidity. The inner lining insures an air-tight seal and helps to prevent escape of the gas, which is employed because of its retardent effect on the development of mold.

CAMERA ANGLES

Conducted by JACOB DESCHIN, A.R.P.S.

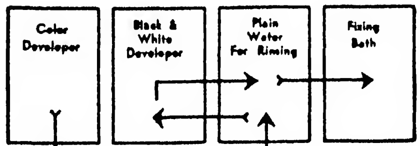
One-Solution Toning and Developing

By combining in one tray a special developer solution with a toning solution of a desired color, it is now possible to make a print in any one of a large variety of colors by direct development in the ordinary way. The means is provided by Develochrome toners, based on a discovery by Anton Bruehl, internationally famous photographer. All you need is three trays, as usual; one for the color developer, the second for a plain water rinse, and the third for the usual fixing bath. The one exception to the regular routine is that no acid or hardener is to be used either in the rinse or the fixing bath. The latter is plain hypo without acid hardener.

The method is really as simple as that, but the effects achieved may truthfully be said to be without limit. And the variety of results may be greatly extended by using a secondary bath known as the "black-and-white" developer in a fourth tray. These four trays provide, by varying the colors, the time of development in each bath, and the paper used, a truly royal road to the world of monochrome color photography.

Say you want to make a print with a snow-blue tone. You set up your three trays, pour plain water in the center tray and plain hypo solution into the third tray. Into the first tray you pour equal parts of the "A" and "B" components of the Develochrome developer, say 125cc of each. To this you simply add 10cc of the Snow-Blue Toner, and you are ready to go to work. The temperature of the solution should be kept within the limits 65 to 70 degrees Fahrenheit.

Six toners are available: red, yellow, blue, snow-blue, sea-green, and sepia. The latter three are used when these specific colors are desired; to mix up colors to produce any desired tone, it is necessary to have on hand a bottle each of the three primary Develochrome colors—red, yellow, and blue—which are mixed in various proportions, the exact quantities being determined by individual experiment.



Two-bath toning tray set-up

The complete process involves the following steps:

Exposure of the print for double the time normally required by the paper for ordinary black-and-white prints.

Develop in the toning-developing bath from two to three minutes, depending on the contrast desired.

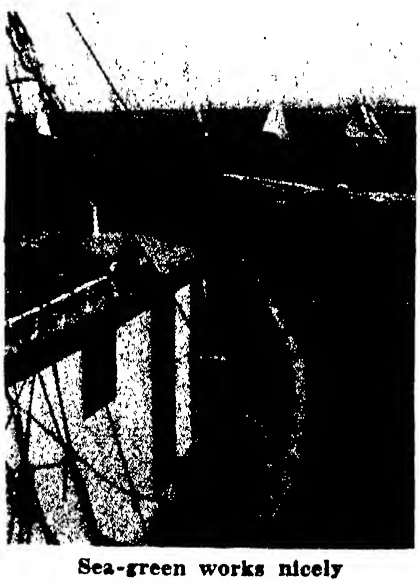
Rinse in plain water.

Fix in plain hypo for five minutes.

Wash for 15 minutes in running water or in ten changes of fresh water in a tray.

Remove excess water with sponge or squeegee, and dry face up on clean photo blotters.

For "off-black" tones, a black-and-white developer is made up with one part of Quinolin developer and 10 parts of water, in a separate tray, and the print developed for part of the time in the color developer and the balance of the time in the second developer. Variations in the time of immersion in the one bath and the other will produce varying results. The print must be rinsed in plain water after each immersion. Prints that



Sea-green works nicely

Snow-blue fills the bill

have already been developed in the usual black-and-white way may be toned by bleaching and re-developing in Develochrome.

Recommended papers for use with Develochrome are the following: Defender Velour Black (all grades and surfaces); Eastman Illustrators Special, News Bromide, Kodalure, Vitava Opal and matte and semi-matte Kodabrom surfaces; Agfa Brovira. Velour Black seems to give the best results with Develochrome, and some workers use this paper exclusively for this work. Personally, we have obtained very agreeable tones with Kodalure, particularly when using Sea-Green.

Sepia is fine for some portraits

By the two-bath method—color-developer and black-and-white bath—a beautiful green tone particularly suitable for forest scenes is obtainable, a result that seems appropriate even for a portrait.

In general, more subtle color values are obtained by using the two baths rather than the color-developer straight. The beauty of the process is that you can command colors to suit your taste and that, through personal experimentation, you may select a shade of any given color varying anywhere from slightly off-black to very vivid.

Since we cannot reproduce here the colors of prints processed by the Develochrome method, we present black-and-white reproductions of several types of subjects that lend themselves particularly to this type of work.

Shooting Lectures

CAMERA clubs sometimes gain much practical information from lecturers, who supplement their talks with demonstrations involving the actual setting up and lighting of the subject. Although some of the members are able to retain all or most of the lecturer's demonstration, too many forget the details, with the result that this information must be picked up again somewhere else when it is actually needed by the individual worker, or inaccurately used due to lack of exact data.

The camera club may eat its cake and have it too, simply by arranging to make a snapshot memorandum of the demonstration. One or two members of the club should be assigned to photograph the various steps in a particular demonstration during the

Main light, spot, and reflector

progress of the lecture, each worker shooting what he feels to be useful. It is obviously better to have two photographers cover the event rather than one; afterward, both sets of pictures can be compared and the most useful, without duplication, retained for the final, complete story.

The method was successfully employed in a recent club lecture-demonstration by Morris Germain, A. R. P. S., who demonstrated fundamental lighting technique in portraiture. The only lighting used was that employed by Mr. Germain in making the demonstration; exposure on fast pan film varied from 1/10 to 1/50 at apertures $f/2.9$ to $f/5.6$. Since the pictures were to show how the lights were placed with relation to the model, the lights themselves were included in the pictures, the resulting prints showing the set-up. In most of the shots, even the lecturer himself was included, perhaps arranging a light or, again, holding a card reflect-

Single light and reflector

or. Two of the pictures are reproduced here to show the type of picture memoranda which club members can take, and how useful such records can later prove to be for all the members of the club.

In this particular instance, all the suitable pictures were enlarged to 11 by 14 inches and mounted on regular 16 by 20-inch boards, which were displayed on a wall in the club.

Tabletop Background

A LARGE print, 14 by 17 inches, behind a sheet of glass to keep it upright and flat, provided the background for the table top, "Homeward Bound." A better way of doing the job would have been to mount the print on a stiffer cardboard and attach it to a wall or other flat support without the necessity of using glass.

Background for tabletop

The glass arrangement happened to be most convenient at the moment, however, and, in order to avoid too bad reflections from the glass, the light was pointed to the ceiling to supply indirect illumination. A small light, partly masked by the print, was used to light the figure from the side. To get both in sharp focus, a small stop, $f/22$, was used.

Got a Spare?

WHEN the enlarger bulb suddenly burns out, you have to stop work right in the middle of things. But if you have a spare bulb handy, all you have to do is substitute the new one for the old, and go right on working. It's just a case of applying the old rule of an ounce of prevention. . .

Gray Equivalents of Colors

WHEN photographing colors on regular "black-and-white" film, they reproduce in various shades of gray when printed on paper. But what specific shade of gray and how much darker or lighter will a particular color reproduce than another? Certainly, the photographer will not

be able to tell unless he has photographed those colors before and remembers just what they were and what their particular intensities or brightnesses were. Likewise, if he changes one type of panchromatic film for another, there will be a difference again because of varying red sensitivity, resulting in a darker gray with one film and lighter gray with another.

One amateur, C. H. Rowles, of the London Terrace Camera Club (New York City), realizing this when he bought himself a set of water colors for use in tabletop set-ups, made himself a chart of gray equivalents in the following manner: On a white card he drew a line in each of the colors, one color below the other, labeling the name of the color alongside. He then photographed the card and thereafter had an accurate guide as to what gray he could expect from any one of the colors, using the same panchromatic film all the time. Obviously, different pan films could be "charted" by photographing the color card with each type of film

Three-Way Bulb

THERE'S a three-way bulb available for a quarter that seems ideal for use in contact printing. Instead of varying the distance of the printing frame, simply adjust the bulb and you have weaker or stronger light at will. Providing about the same result as would a rheostat, the bulb burns 40, 60, or 100 watts as desired. You just turn a collar at the base of the bulb and any of the three light intensities is yours

More on Latensification

REFERRING again to the subject of latensification recently treated in this department, we are now able to give a procedure recommended by Du Pont for increasing the sensitivity of their Superior films, 1, 2, and 3. Said to increase the speed of the films about three times normal, exposure meter ratings that may safely be used with latensification, are as follows:

	Weston		*G. E.*		*American Scheiner*	
	Day.	Maz.	Day.	Maz.	Day	Maz.
Superior 1	100	80	125	100	29	28
Superior 2	200	160	250	200	32	31
Superior 3	240	200	300	250	33	32

Use a dark red or dark green safelight employing a 10-watt or weaker bulb. To determine the effect of a particular safelight on film at a given distance from the light, try the following experiment: Take several identical pictures of any subject, underexposing about two lens stops. In the darkroom, cut the film into short lengths, each long enough to include one whole negative, and arrange the strips at varying distances from the safelight, emulsion side facing the light. Pin down flat and use black paper supports for the film. With film strips mounted one behind the other, making sure that they do not cast shadows upon one another, expose the set of test strips for 30 minutes. Identify each film as to distance; then develop, increasing the developing time 50 percent above normal since latensification decreases the contrast. Inspect the results and pick for future guidance the distance that produces the greatest amount of shadow detail. The slight overall fog will not affect the printing of the negative, according to the makers.

Indoor Rink Shooting

CONFRONTED with a rather monotonous daylight illumination coming through the skylight and the curtained windows of the indoor ice skating rink we visited in town one morning, there seemed nothing to do to pep up the lighting but to utilize in some way the direct beams of sunlight that managed to cut through between the curtains and strike the rink. This we did by withholding our fire until the subject moved into the beam or could in some way maneuver her movements so that the beam could be made part of the composition. In this way we were able to obtain the next best thing to artificial spotlighting and get interest into the picture

"Beginner"

Candid Shots in Photo Stores

EVER notice your brother fans browsing around the counters, and display stalls in camera stores? Probably you've been so busy browsing yourself that you have paid no attention

to the others. Next time, try being objective, but make sure you have your candid camera along. In one of the large New York stores—Willoughby's, in fact—a trio of young fellows was inspecting a strip of miniature negatives. One of the lads was holding the strip stretched out, while the other two, in rather humorous attitudes, assumed unconsciously, of course, were taking a look, too. All three had concentrated expressions, one of them screwing up his face in a manner indicating a desire to scrutinize the negatives very carefully. It made a perfect picture, but no one was ready to shoot it. Besides, it needed a flash gun. Little incidents of the sort happen all the time, one of the salesmen told us. Make it a point to look for them; never can tell what you may catch.

Flash Gun for Low Priced Cameras

A LONG list of low-priced Kodak, Agfa, and other camera makes having pre-set automatic (self-setting) shutters can be fitted with Kalart's new Compak Speed Flash gun, the manufacturers announce. The Battery-Flector unit, designed expressly to accommodate the midget bayonet-base flash bulbs, comprises Kalart's Concentrating Reflector with its bulb ejector and a built-in battery holder containing two standard size batteries.

Baby Bottle Stoppers

ONE worker solved the problem of keeping solutions of concentrated developer by employing the familiar eight-ounce baby bottles, rubber stoppers and all. By distributing his developer in eight-ounce bottles, his solutions always fill the bottle and he thus avoids oxidation caused by partly filled bottles. The rubber cap makes an ideal cover, keeping the contents air-tight.

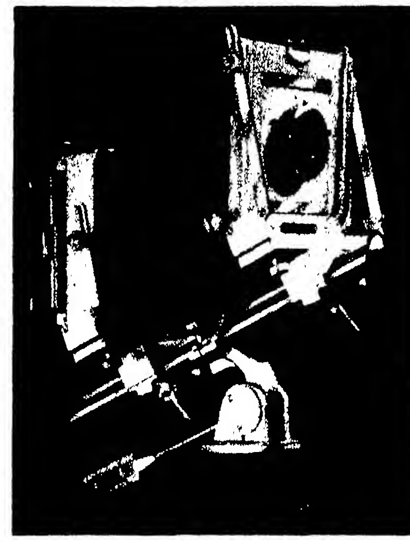
• • •

WHAT'S NEW

In Photographic Equipment

BEE BEE PLATE HOLDERS for Bee Bee, Maximar, Recomar, Voigtlander and similar cameras are now available in the 6½ by 9cm size, through photographic dealers. The design of these American-made plate holders is a distinct improvement over the imported product. They are of rigid, all-metal construction and are easy to load. A fine quality of felt is securely cemented to the frame in a manner which eliminates loosening or tearing. These holders list at $1 each. Cut-film sheaths for both 6½ by 9cm and 9 by 12cm sizes also are available, priced at 12¢ and 15¢ respectively.

GRAPHIC VIEW CAMERA: 4 by 5 view camera made entirely of metal. Various adjustments permit wide latitude in control of linear perspective, sharp field, and form of subject photographed. Front rises three inches, tilts forward or backward, swings and shifts either to right or left. Back also swings, tilts, shifts. Removable lensboard; camera also accepts regular 4 by 5 and 5 by 7 Speed Graphic lensboard. Bellows extension 12½ inches. Graphic or Graflex ground glass back. Inverted



V-section bed of aluminum alloy forms support upon which both lens and film may be focused. Rack and pinion may be locked in any position. Combined camera base and revolving-tilting tripod head built integrally with camera. Built-in spirit level on top of camera. Reversible back may be removed and re-positioned for vertical or horizontal pictures.

AIRCRAFT MODEL VICTOR: Improved model of 16mm Victor movie camera, with speeds 8, 16, 24, 32 and 64 frames per second, all set by dial. "The new unit," write the makers, "turns in results of remarkable accuracy at all speeds over a range of temperature down to zero and even

lower. In fact, the speed tests were made in a cold storage warehouse at -10 degrees and the camera was left overnight to simulate the toughest conditions likely to be encountered in practice. The speeds were tested with a neon type stroboscope and the settings of the instrument were not touched during the run at any speed. Even at the end of the winding the

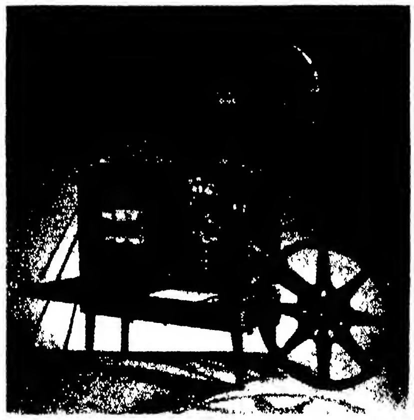
speed was still so close as to cause only a very slow 'creep' under the stroboscope. This is so accurate that time intervals for most scientific purposes can be obtained merely by counting frames, without the necessity of supplementary timing devices. The value of this for both scientific and industrial research is apparent; the new camera will be found very useful for sport pictures such as analyzing one's golf stroke."

LUXOR MERCURY FOOT SWITCH ($4.95): Double mercury contacts, eliminating possibility of sparking, burning, or eventual wearing out of metal contacts. May be used safely on any electrical equipment using from 60 to 250 volts A.C. or D.C. Provides three outlets, one for steady pilot or safelight; two for enlarger or printer, operating simultaneously. Equipped with rubber feet.

KRIEGR-O-TONE 4 BY 5 COLOR CAMERA ($147.50): Complete with Velostigmat $f/6.3$, 7¼-inch lens, in Betax shutter, speeds to 1/100 second, cable release, two double registered holders with pressure plates. Movements include rise and fall, swing and front tilt, bellows extension. Features include natural position of hand holds on each side of camera; anchored trigger release worked by thumb of right hand while holding camera steady; weight, 6 pounds with holders and lens shade; handy sight mounted on top center. Balanced for use with

Photoflood without filter. Weston speed about 6; daylight, Weston 4. KB-6 filter used for daylight shots; KF-1 for flash. Accessory filters and combination lens shade and filter holders complete $3.75 each. Defender type B Tri-Color combination film used.

SOUND KODASCOPES ($295 to $520): Power output 10 watts to 40 watts. Choice of six lenses, in focal lengths one to four inches, available for each projector. All models accommodate 1600-foot reels for uninterrupted 44-minute show at 24-frame sound speed. All portable. Special provision for smooth film movement at point where it is "scanned" for sound. Either variable area or variable density sound films can be used with all models. Model FS-10 ($295), complete with two-inch $f/1.6$ lens, 750-watt lamp, all tubes, speaker and speaker cable, extra exciter lamp, oiling and splicing outfits. Any other lens may be substituted, with price adjustment. Rated output 10 watts; operates only on A.C., 50-60-cycle, 100 to 125-volt. Projector and speaker built into one compact case which divides into two sections, one for 10-inch permanent magnet speaker, other



serving as platform for projector. Also space for 1600-foot reel and accessory equipment. Model F (with two-inch $f/1.6$ lens, $370) operates on D.C. or A.C., 25-60 cycle, 100 to 125-volt; 10-inch electro-dynamic speaker; built-in motor generator; jack for microphone or phonograph pick-up; in two cases—speaker case has brackets to hold projection screen. Model FB (with two-inch $f/1.6$ lens, $400), mounted for projection in sound-proofed blimp case, top of which conceals four-inch supporting legs and lifts projector to proper level for clearance of 1600-foot reels. Model FB-25 (with two-inch $f/1.6$ lens; with single speaker, $425; with double speaker, $450), available either with single 12-inch permanent magnet speaker or with two of these speaker units, allowing use of full rated capacity of 25 watts. Sound-proofed blimp; jack for "mike" or phonograph pick-up, permitting sound from either one to be mixed with sound from film track. Double speaker units can be used side by side, or separated. Model FB-40 (with 100 feet of speaker cable; with two-inch $f/1.6$ lens, $520): rated capacity of 40 watts, operates only on A.C.; 12-inch permanent magnet speaker. Separate jacks for microphone and phonograph pick-up, each with own control. Lenses available: one-inch $f/2.5$; 1½-inch $f/2.5$; two-inch $f/2.5$; two-inch $f/1.6$; three-inch $f/2.$; four-inch $f/2.5$.

FILMO "SPORTSTER" 8mm CAMERA ($69.50): Equipped with Taylor-Hobson 12½mm $f/2.5$ lens. Camera speeds, 16, 32, 48, 64 frames per second. Lens interchanges with choice of seven speed and telephoto lenses. Has automatic footage dial, automatically reset each time camera is loaded. Single frame exposure. "Drop in" loading—no sprockets to thread. Fully enclosed spyglass viewfinder equipped with masks for telephoto lenses. Built-in exposure guide.

YOUR FIREARMS and FISHING TACKLE

Conducted by A. D. RATHBONE, IV

INTEREST IN FIREARMS *is traditional with American men; fishing tackle is a requisite of one of the world's oldest occupations. Scientific development of guns and tackle, in the use of which millions yearly find sport and recreation, fathers this monthly department which welcomes correspondence from readers.*

Let's Open The Trout Season

A long, long time ago we camped on the banks of Michigan's Little Manistee river the night before we opened our first trout season. We were so green at this trout-fishing business that we spent most of the evening poring over the pages of our first Weber catalog in an effort to identify newly acquired lures by comparing them with the catalog's excellent color plates. That's why we took the catalog along, and it continued to be a part of our duffle for many moons.

We believe American fishing tackle catalogs are an invaluable source of attractive and informative material

A Manistee river rainbow

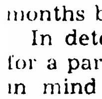
and we wouldn't be without them. Each one is an angling encyclopedia, filled with constructive suggestions on the art of fishing, on tackle selection, how and where to use it, and many other helpful hints. Each tells of tackle and lures for bass, pike, pickerel, muskie, bluegill: for salt water men as well as fresh water devotees, but this being the dawn of a new trout season, we'll specialize in the stream fishing equipment now and review other types of angling later. As Izaak Walton said:

"I care not, I, to fish in seas,
Fresh rivers best my mind do please."

If you're like us, there's much to do before opening day. Take your rods, for example. Need new windings? Are ferrules, guides, or tips loose or cracked? How about a new, protective coat of varnish? But when it comes to repairs, remember, unless you're capable of performing a highly specialized job, don't try it—you may ruin the balance of a delicate piece of bamboo mechanism. "Balance" in American fishing tackle is the art of coordinating action of rod with size of line so that energy of the rod is transmitted to the line with maximum efficiency and minimum effort, thereby producing the best possible conditions under which to lay a fly properly on water. Improper windings, too much or poorly applied varnish, an inexpertly repaired tip may completely upset this vital factor of balance. It doesn't pay to take chances. If a rod needs repairing, send it to the people who made it.

Weber's 2-piece 4-ounce fly rod

As in the construction of a fine rod, time and expert hand labor are important factors in production of a fly fishing line. Long-fibered Japanese silk must be treated with waterproofing compound before it is braided. Then, with lapses of several days between each, the line receives a series of applications of a special oil solution, impregnating the line to the core. After each treatment, every foot of line is hand-rubbed and honed, and the completed product is aged for months before you buy it.



Dry fly

In determining correct size of line for a particular fly rod, we must keep in mind the definition of "balance" and endeavor to coordinate the "action" of the rod—not its length and weight—with the line to bring about the ideal mechanical conditions for the laying of a fly. The rest is up to the fisherman, who must develop his own skill through practice.

Although perfect complement of rod and line may seem confusing, it is not difficult to achieve. Again we refer to the encyclopedic 1941

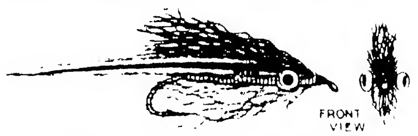
South Bend Automatic

American tackle catalogs, many of which contain helpful charts and illustrations on this subject of balance. In addition to this fund of clearly stated, easily understood information on the proper line for your rod, The Weber Lifelike Fly Company offers a "Rod-and-Line Matching Service." Simply pack your rod carefully and ship it—*fully insured*—to the "Matching Service Department" at the Weber factory and you will receive, without charge, the scientific knowledge and competent judgment of their experts. Your rod will be promptly returned with a tag attached giving you detailed "Line Recommendations."

Weber's "Silent Knight"

In reels, the trout fisherman does not face the problem of the surf caster, the troller, or the bait caster: the trout reel is primarily a storage place, spare line for playing the hooked fish being customarily looped in loose coils in the left hand. Many stream anglers prefer the automatic type of reel, a development that has reached a new high in mechanical efficiency. Equipped with larger, stronger springs, the automatics will reel in from 75 to 90 feet of line, and some of the newer models are self-winding. One cardinal principle that should be embodied in all reels is the solid side spool disk. Perforated disks permit the line to bulge at the openings, a condition that will quickly cut and chafe the line.

Normally, the tapered leader is for dry flies, the level for wet fly fishing. Length, degree of taper, color, tensile strength, and the use of droppers all come within the realms of stream and weather conditions, personal preference, and casting skill. If you can learn to handle a long, finely tapered leader in dry fly work, your chances of piscatorial success will immeasurably improve.



The new Erskine Minnow

In the matter of terminal tackle, we come to that perennial controversial question of "which fly?" Since Izaak Walton wrote about his "jury of flies (12), likely to betray and condemn all the Trouts in the river," the number of patterns has increased to more than 10,000. No man can satisfactorily tell you which half-dozen or so flies will prove to be the best for you—it is again largely a matter of personal preference plus a touch of Lady Luck's magic wand.

However, two years ago it was our pleasure to conduct a nation-wide trout fly survey through the columns of *National Sportsman*. The poll drew replies from 23 states, named 319 different patterns, and, after final compilations were made, the Weber people printed a folder showing both national and regional results of the survey, and they attractively packaged the winning lures into what is known as "The All-American Trout Fly Selection." We make no claim that possession of a set of these "All-American" dry flies, wet flies, and streamers will solve all trout lure problems, but it will present a cross-sectional view of the nation's trout fly preferences and form a logical base from which to start. We'll gladly send you one of these folders—free, of course.

Since that first night on the Little Manistee there have been countless camps, on waters near and far, but none has succeeded in topping the thrill of our initiation into the mysteries of trout fishing. Through the years we've annually pored over the new catalogs and learned much. In them you'll find all we've said and more. They're profusely illustrated and are briefly reviewed in the following paragraphs. Tell us which ones you wish and we'll send them to you. But despite the best of suggestions and advice, improvements in tackle, and inventions of new lures, trout fishing is still exactly what Izaak Walton so aptly termed it when he said, "O, sir, doubt not that angling is an art. Is it not an art to deceive a trout with an artificial fly?"

Library of Catalogs

ASHAWAY LINE & TWINE MANUFACTURING COMPANY'S series of world's record catches on Ashaway lines is an imposing one. Kip Farrington and the late Zane Grey are but two of many noted deep sea fishermen who have used Ashaway products. Also casting, trolling, and trout lines.

CREEK CHUB BAIT COMPANY needs no introduction to anglers. Five of the winning fish in *Field & Stream's* 1939 contest and eight in the *National Sportsman* event were taken with Creek Chub lures. A total of 35 enticingly colored pages of plugs, baits, fly rod lures, reels, casting rods, and miscellany.

FRED ARBOGAST'S Hawaiian Wigglers, with their vari-colored rubber "skirts" can out-hula the quivering grass dresses of Waikiki Beach anytime, so far as fish are concerned. It's a tried and proved lure, conclusively witnessed by photographic evidence in the catalog.

JAMES HEDDON'S SONS ably carry on the business founded by their father, Jim Heddon, with such well known lures as "River-Runt-Spooks," "Crazy Crawlers," "Chugger-Spooks," and a host of others. The Heddon line is extensive, includes rods, reels, all kinds of lures, including bass bugs for

"FISH AND FEEL FIT"

Says the
Fishing Tackle Manufacturer's Association

LEAPING SILVER, by Lee Wulff. An Alaskan by birth, an ichthyologist and an expert angler by dint of exhaustive research in many waters, the author has followed his two other successful books, "Lee Wulff's Handbook of Fresh Water Fishing" and "Let's Go Fishing," with this splendid dissertation on salmon angling in Newfoundland. For the experienced salmon fisherman, as well as for the would-be *Salmo salar* nimrod, this book is packed with informative helpful data "On the Life of the Salmon," "On Where Salmon Lie," "On Salmon Tackle," "On Hooking the Salmon," "On Playing the Salmon," all simply and informally told. For the sportsman who collects beautiful books, there is a Limited Edition of 540 autographed copies in half leather, in slip case, with full color frontispiece. 150 pages, 6 by 8 inches, 72 action photographs, 26 sketches. $3.60.

THE THEORY AND TECHNIQUE OF FRESH WATER ANGLING, by John Alden Knight. If all anglers of this generation could have had the advantage of reading this book before beginning to take their trout and bass fishing seriously, they would have been saved much time, money, and grief. If they, together with prospective anglers, will read it now, they will find a mine of valuable knowledge, enjoyably presented by the Instructor of Fly Fishing at Columbia University, the unique position held by the author of this and other angling volumes, as well as of the famous Solunar Tables. 223 pages, 18 illustrations, 4 color plates of lures. $3.85.

A HANDBOOK ON SALT WATER FISHING, by O. H. P. Rodman. The former editor of "Hunting and Fishing" has compressed between these covers knowledge acquired from his years of angling. Intensely practical and helpful. 274 pages, 56 illustrations. $1.85.

PRICES QUOTED INCLUDE POSTAGE

SCIENTIFIC AMERICAN

24 West 40th Street, New York City

trout rods, and every accessory. It has earned testimonials from Cal Johnson, Mack Sennett, Gene Tunney, Lynn Bogue Hunt, Irvin S. Cobb, and other noted anglers.

MONTAGUE ROD AND REEL COMPANY attractively displays both fresh and salt water rods in natural color. These include fly, salmon, bait casting, and trolling rods in one,- two,- and three-piece types; tarpon, tuna, and swordfish rods; surf casting, weakfish, and squidder rods, together with accessories.

OCEAN CITY MANUFACTURING COMPANY, in addition to their own widely known brand of reels, are now also producing the famous Edward vom Hofe reels and accessories. The 50 pages of this catalog will delight the salt water fisherman especially, but it likewise includes trout and fresh water reels, as well as spears, dart shanks, gaffs, and other sea-angling necessities.

PFLUEGER FISHING TACKLE, made by Enterprise Manufacturing Company, has won the respect of anglers from coast to coast. Picturing 51 varieties of fresh and salt water game fish, the catalog recommends tackle specifications for each, refers readers to pages on which equipment is described and illustrated.

SHAKESPEARE COMPANY'S "fishing ambassador extraordinary" is Tony Acetta, Professional Casting Champion. In motion pictures, as well as diagramatically in the catalog, Tony shows you how it's done. This 86-page publication has everything in the tackle line with which to emulate Tony, and with Shakespeare's famous "Wondereel," it can easily be done.

SOUTH BEND BAIT COMPANY'S newest guide to fishing tackle depicts every angling need (January 1941). Its 130 pages, many in full color—including pictures and descriptions of 34 species of fish—comprise a veritable text book on angling methods and equipment.

WEBER LIFELIKE FLY COMPANY for 22 years has produced the "Fishing Bible" of America's trout fishermen. The 112 pages of the 1941 edition are, as usual, packed with indispensable trout fishing lore and information. Its color plates of wet and dry flies, streamers and other lures provide invaluable assistance in selecting this year's supply of tackle. There is nothing in trout fishing equipment that is not covered in this publication. (As it is Weber's custom to charge for the catalog and to offer, in addition, a new fly or a 10-yard coil of Vec leader material, please send 25 cents with your request and specify whether you wish the fly or the Vec. —*Ed.*)

Boots

ONE absolute necessity for the early season stream fisherman is a pair of good boots. They may be hip boots, as shown, or knee-height rubber shoes, or the full length waders, depending on the kind of stream to be fished. Whether your opening-day river be large or small, shallow or deep, swift or placid, be certain you are properly booted for comfort and protection. There's nothing that so ardently dampens one's fishing ambitions, literally and figuratively, as the steady, irritating seepage of cold spring water into either leg of a pair of boots. The newest catalog of L. L. Bean, Inc., makers of canvas, leather, and rubber specialties, pictures waders of the stocking type for use with wading shoe, and the heavy-soled variety. There is also an extra light pair of stocking waders, patterned on the English mode, weighing 42 ounces, as well as many other styles of outing and fisherman's footwear. Want a catalog?

A necessity, good boots

Shotgun Preferences

INDICATIVE of preferences in gage, barrel length, and choke of shotguns are the following figures, taken from an Ithaca Gun Company report.

How Ithaca Model 37 Featherlight Repeating Shotguns Were Ordered During 1940

Gage & Length	Percent of each Gage & Length	Percent of boring ordered in each gage and length: Full Choke	Modif. Choke	Imp. Cyl. & Skeet
12/32	1%	95%	5%	
12/30	21%	90%	10%	
12/28	21%	23%	74%	3%
12/26	3%	5%	28%	67%
16/30	1%	90%	10%	
16/28	31%	41%	57%	2%
16/26	6%	7%	48%	45%
20/28	10%	60%	35%	5%
20/26	6%	15%	53%	32%

Model 37 has a five-shot capacity, with plug to conform to the three-shot Federal Migratory Bird Law. It has a chamber length of 2¾ inches, stock of 14 inches, with drop 1⅝ inches at comb and 2¾ inches at heel. All barrels are thoroughly proof-tested and the attractively etched receiver has solid top and sides for safety. Stock and forend are of genuine black walnut and are nicely checkered.

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with a list of available titles, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for.

THE AVIATION MECHANIC

By Carl Norcross and James Quinn

THOROUGHLY up-to-date and comprehensive in treatment, the text of this book deals with the construction and maintenance of modern airplanes of every type—civil and military, large and small. The introductory chapter deals with the importance of the mechanic's work—his necessary function in all branches of aviation. The point is stressed that the mechanic holds the most important position in the field but one for which he must train himself thoroughly in order to contribute his part. After introductory material about the airplane and how it flies, the text goes on with the construction of planes and their maintenance, describing materials and methods. Throughout the book the reader is lead by simple step-by-step methods which present facts in easily assimilated form. (564 pages, 6½ by 9 inches, a large number of photographs and drawings.)—$3.60 postpaid.—*A. P. P.*

SCIENCE IN INDUSTRY

By Professor A. M. Low

LABORATORY work squarely underlies most of modern industrial development, and this book shows how this has come about. The fields chosen are in food, canning, plastics, coal, synthetics, oil, shipbuilding, aviation, printing, photography, and others. The book is entirely non-technical and easy reading. (160 pages, 5¼ by 8½ inches, 15 illustrations.)—$1.85 postpaid.—*A. G. I.*

WILDLIFE CONSERVATION

By Ira N. Gabrielson

DURING the past ten years no project of so vast a scope has created such wide-spread interest or received such universal support as efforts toward conservation of our natural resources, both inorganic and organic. Concerning himself only with the latter as resources that can be and are affected by man, the author, writing with authority gained from practical, constructive experience as Director of The Fish and Wildlife Service, U. S. Department of the Interior, clearly, simply, and factually explains the intricate inter-dependence of humans and wildlife, of soil and water, of forestry and land utilization. Conservation of our organic resources is a problem that requires close application of almost every known science; it is a momentous question that should seriously interest every person in this country. In a volume that qualifies both as text-book and as exceedingly readable literature, the author has expounded the problem and delineated the scientific approach to the solution. (250 pages, 6 by 9 inches, 56 illustrations.)—$3.60 postpaid.—*A. D. R., IV.*

DIESEL MONITOR

By Julius Rosbloom

PRESENTED in question and answer form, the text of this present book has been prepared with a view to simplifying the solution of problems encountered in Diesel service work. This is no highly technical textbook, but rather has been prepared for the average man whose knowledge of the field of Diesel engineering is confined to fundamental principles. It carries the official endorsement of the Diesel Engineers' Association and the United License Officers U. S. A. (528 pages, 5½ by 7¾ inches, numerous drawings and photographs.)—$5.10 postpaid.—*A. P. P.*

BIOLOGY

By Howard M. Parshley, Professor of Zoology, Smith College

SURVEYING only the main facts and principles of modern biology, this relatively brief book avoids entering on the technical details which so many scientist-authors, naturally in love with their work, think every reader surely must be made to learn. It is an elementary college textbook and is lucid. (232 pages, 5¼ by 8½ inches.)—$2.35 postpaid.—*A. G. I.*

HANDBOOK OF HEARING

By A. F. Niemoeller

PRACTICAL chapters on types of hearing aids, how to choose, buy, use, care for, and test them, together with other pertinent information, make up this excellent little book. Though its publisher sets an exhorbitant price

—OUR BOOK CORNER—

on it, considering the low production cost of a simple volume like this, if its compact, meaty content is taken as the criterion of its value, it should come cheap, after all, to persons who seek hearing aids. It canvasses systematically just the variety of practical questions whose answers could be obtained only after several costly calls and persistent quizzings of an informed ear specialist. They cover questions about existing types of hearing aids that are on the market, actually naming names and giving addresses, and even prices. (156 pages, 5¼ by 8 inches.)—$3.10 postpaid— *A. G. I.*

MODERN PLASTICS CATALOG—1941

YEAR by year the growth of the plastics industry seems more and more amazing to those outside the industry. This volume seems to cover the whole field, discussing and illustrating, with many hundreds of pictures, the entire industry, including plastics engineering, materials, molding and fabricating machinery and equipment, plastic castings, synthetic fibers, and so on. A comprehensive index and directory takes up the last few pages. (476 pages, 9¼ by 12 inches, padded plastic leatherette.)—$3.50 postpaid in U. S A.—$4.00 postpaid, foreign.

PHYSICAL CHEMISTRY

By Louis J. Bircher, Ph.D.

LABORATORY experiments are included in this textbook, which is subtitled "A Brief Course," and covers such subjects as structure of atoms and valence, theories of polarity and ionization, the gas laws, solubility and solutions, surface energy and the colloidal state, and so on. (420 pages, 6¼ by 9¼, illustrated.)—$3.10 postpaid.

EARTH SCIENCES

By J. Harlen Bretz, Ph.D., Professor of Geology

COMPACT, brief, elementary textbook covering the rudiments of meteorology (36 pages), oceanography (22 pages), and physical but not historical geology (177 pages). Suitable for home reading or study. (260 pages, 5½ by 8½ inches, 123 illustrations.) —$2.35 postpaid.—*A. G. I.*

GEOPHYSICAL EXPLORATION

By C. A. Heiland, Sc. D.

MONUMENTAL, all-around, technical treatise on geophysical prospecting, by the professor of geophysics at the Colorado School of Mines who for years has been an outstanding world authority on this subject. Its first 57 pages consist of a rapid, elementary survey of all the methods; the remaining 900 cover the same ground in close detail and in the more technical language of geology, physics, and

higher mathematics,' as follows: 226 pages on the gravitational methods, 144 pages on the magnetic method, 282 pages on the seismic methods, and 206 pages on the electrical methods. Then follow 45 pages on geophysical well testing and 97 on miscellaneous methods, such as the radioactive and acoustic. This treatise, because of its comprehensive, detailed, and authoritative nature, is certain to occupy a position of major importance in the world of geophysical prospecting. (1013 pages, 6 by 9 inches, numerous illustrations.) — $10.10 postpaid. — *A. G. I.*

WHAT ARE THE VITAMINS?

By Walter H. Eddy, PhD.

COMPACT, solid, scientific survey of existing knowledge of each of the vitamins by the noted professor of physiological chemistry at Teachers College, Columbia University. For chemists, biologists, nutritionists, physicians, and so on—also for anyone else who seeks a more technical than popular work and who already knows a little about biological sciences and chemistry. Extensive bibliographies cite surrounding scientific periodical literature. (247 pages, 6 by 9 inches, 7 illustrations.)—$2.60 postpaid.—*A. G. I.*

OUR WONDERFUL UNIVERSE

By Clarence Augustus Chant, M.A., Ph.D., F.R.A.S.

AN EASY introduction to the study of the heavens, by the emeritus professor of astrophysics and director of the David Dunlap Observatory at the University of Toronto. Mainly it is for juveniles, yet it is not too juvenile: perhaps about right for an adult wishing to get a first view of general, elementary astronomy without risk of bogging down in technical detail. (281 pages, 5 by 8 inches, 214 illustrations.)—$3.00 postpaid.—*A. G. I.*

TORCH OF CIVILIZATION

By Matthew Luckiesh

IN THIS popular—rather than technical—yet informative, book, the Director of the Lighting Research Laboratory of the General Electric Company tells the story of man's conquest of darkness from the first oil lamps of Babylonia 6000 years ago to the high-pressure mercury arc which challenges the sun. The first half of the book is historical: illumination before electricity, a romantic, unfolding account. The second half pertains to successive improvements in the electric lighting art from the arc lamp, through the early filament lamp, mercury vapor lamps, fluorescent lamps. Radio beacons, light and sight, the modern lighting art and painting with mobile light, receive separate chapters. (269 pages, 5½ by 8 inches, 16 illustrations.)—$3.10 postpaid.—*A. G. I.*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

While a large majority of amateur telescope makers today are of the genus American, subgenus North, and species Yankee, the hobby also has taken root the world over. From time to time we have published here the descriptions of telescopes made by amateurs in India, and Figure 1 shows one more of these. Kamalesh Roy, of Lhasa Villa, 80 Park St., Calcutta, India, is the maker and this reflector has a 7" mirror of focal ratio 9. Roy made two such mirrors, one for himself and one for the University of Dacca, Bengal. He says that, fortunately, Prof. M. N. Saha, F.R.S., at Calcutta University, took interest in his work and encouraged him to build the mounting at the University's workshop. Prof. Saha (pronounced "shah") is an astrophysicist of world-wide note. The telescope is mounted on the roof of the University Science College Building.

A series on telescope making, by Roy, appeared in the November and subsequent numbers of the Calcutta magazine *Science and Culture*, where his connection with the Palit Laboratory of Physics at the Calcutta University College of Science is mentioned.

When his telescope was completed, Roy took one of the discarded tools, of thin ½" glass, ground it to $f/4.3$ and

Figure 1: **Roy and telescope**

made of this the primary for a Cassegrainian telescope. Performance was not very good, and Roy therefore asks just how far one can safely go with the thickness-to-diameter ratio of glass mirror disks. Answer is difficult and not sharply definitive for individual cases, or even for general cases. That is, while a ratio of 1 to 8 is usually recommended (sometimes even 1 to 6), this includes a rather liberal factor of safety. But if the worker is willing to gamble, he may run his ratio along to 1 to 10 or 1 to 12 with fair chances of good results. It *has* even turned out satisfactory at ratios like 1 to 20, but this is much like skating on thinner and thinner ice. If only every disk of glass were identical with every other disk of glass, and if every telescope maker were identical with every other telescope maker, we probably could refine the matter to a definite limiting place.

Thus, nobody can give a set answer to this question. If you're a born gambler try a 1:50! Such a disk probably would be useless, yet who would dare dogmatize, even here, without hedging? One piece of glass out of a dozen, at 1:50, might miraculously stand up. Some born gambler with sporting instincts and lots of time on his hands may want to see just how far he can pursue fate by making thinner and thinner mirrors till he thus receives as much punishment as he can endure.

Clubs of amateur telescope makers and astronomers in various centers have from time to time started 20" reflecting telescopes as group projects but none of these projects ever has been reported as completed. Evidently an individual can start a 20" after a club does, yet finish before it—William Buchele of Toledo, for example, whose 20" was described here in October 1939, and who went straight through the work without taking time out to differ with himself. Now the Northwest Amateur Astronomical Society of Detroit has tackled a 20" and we predict that Detroit will finish it. A. J. Walrath, 14024 Archdale Ave., Detroit, Mich. sends the photo in Figure 2 and says it is the 20" Pyrex disk after being trued up and with a groove ground in the edge for a locking ring. "A spiral spring, adjustable in tension, will be attached to this ring," he explains, "and by this arrangement the pressure of the mirror on the tool can be adjusted as grinding and polishing conditions require. In the illustration a sub-diameter tool, rotating at 40 R.P.M., is shown. This is used for rough grinding. The mirror, when completed, will be an $f/7$.

If you want to get out of grinding and polishing your mirror by hand, yet if you also want to get out of building an elaborate machine to do the same job of work, you can without very much trouble throw together a sort of demi-machine. That is what James L. Russell, an attorney at law, Chester-twelfth Building, Cleveland, Ohio, did, as Figures 3 and 4 show. He calls it his "Man Friday" and says it takes the "swets" out of the grinding wets.

Lower half is a board swiveled over a shelf on a vertical bolt (the lower end is discernible in Figure 3). The tool is held between wooden end pieces attached to this board.

Upper half is a pear-shaped piece of wood (to afford access to the mirror disk to rotate it occasionally) with a central hole to drop over the handle of the mirror. This part is actuated by a horizontal pitman driven from a lathe or what-have-you.

In Figure 3 the upper, or horizontally reciprocating, half is shown lifted off the mirror and tipped up

Figure 2: **Detroit twenty-inch**

on edge above the mirror button. The fork-shaped object to right is a guide standing on its own loose base. Through this guide the pitman runs, and when in use it is clamped to the shelf with a C-clamp and shifted sidewise if side strokes are temporarily desired.

The pitman is hinged on a bolt and crosspiece over the mirror (Figure 4), but it will be better if these are kept considerably lower than those shown, since a high point of application of effort tends to tip the mirror and cause turned edge.

The tool should be rotated now and then by hand—not very important in earlier stages of grinding—and the mirror may be turned when desired, simply by giving it a turn by hand while you sit and watch the slave do your drudgery, as you feed the Carbo to it and struggle to keep awake. Possibly the latter also would take care of itself automatically if you were to attach sandpaper to the pitman, then do your nodding with your nose over it. [For this latter brilliant contribution your scribe does not, however, take credit since a friend's dog really furnished the germ of the idea. Like many another mutt, old "Tote" enjoyed the winter warmth of a kitchen stove and, if the oven door were left open, would stand and insert his entire head well into the oven and soak up heat. Soon he would drowse, and then his head would gradually sink. Finally his wet nose would touch

the oven floor and there would be a hiss of steam and Tote's head would jerk suddenly upward, whacking the top. But he would not withdraw—the place was just too good. So the cycle

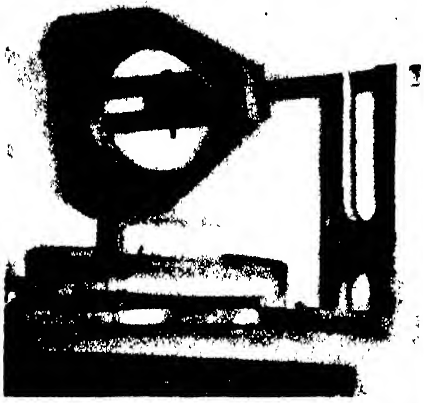


Figure 3: **The Man Friday rig**

would begin again: sink, hiss, jump, sink, hiss, jump, at about one stroke per minute. Two lads—your scribe and his chum—slandered the dog by calling him a poor old fool, but this scientific canine was only trying his best to give them the inspiration for an interval timer.]

ALL of the above was light, easy reading, so put on your workin' pants for the following, which isn't.

TREND away from prisms and toward flats for diagonals in reflecting telescopes is growing. In "ATMA," page 282, Hindle urges flats for best results. In the October, 1940, number, Wates discusses the subject favorably to flats, and now H. H. Selby, author of the chapter on flat making, in "ATMA," quantitatively investigates errors caused by prisms, giving us something definite that we can lay hold of and showing how damaging prisms can be in some cases. "Every now and then," he writes, "someone

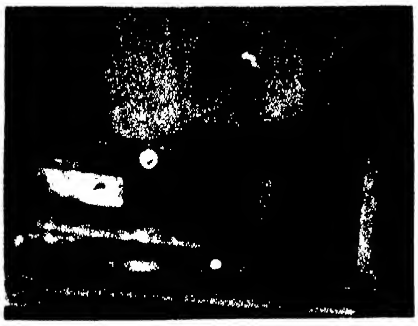


Figure 4: **Friday at work**

asks me why I use diagonals instead of prisms; or remarks, 'That RFT worked fine till I put in my diagonal eyepiece'; or says, 'This plate from my Newtonian is fuzzy, yet you checked my mirror and said it was OK.'" Here is Selby's analysis, and let not those grimacing goblins, the complicated formulas in it, scare you a bit, since they turn out, on closer examination, to require nothing worse than substituting some known values

for symbols and then doing some common arithmetic. Selby writes:

If even a perfect prism is used to deflect the rays from a perfect paraboloid to the side of the telescope tube, the correction of the mirror will be adversely affected and the telescope will perform as if the mirror were over-corrected for axial spherical and axial chromatic aberrations. Also, some chromatic variation of axial spherical correction will be introduced. These effects are slight, however, in the average case. Because the effects of prisms on the performance of telescopes have been the subject of many discussions with TNs, formulas for computing these effects are given here for reference.

Spherical aberration: In Figure 5, a marginal ray is shown reflected from the mirror to the original focus, F_o. When glass is interposed, the ray is refracted and reaches the axis, Fm. The error introduced by this refraction will be a function of the following variables:

R = radius of curvature of center of mirror
R_r = radius of curvature of edge zone of mirror
r = radius of mirror
T = thickness of glass equivalent to the prism used, which equals side of cathetus face
n = Refractive index of prism. No subscript indicates that n is for a wavelength of 5893 A.U

By substituting the proper values of any specific example in the following equation, the distance $\overline{F_o F_m}$ which computers call $\triangle$ sph for spherical aberration, can be found for any color of light.

$$\triangle Sph = \frac{T}{n} - \frac{T\ (R_r - 2r^2)}{\sqrt{n^2R_r^4 - 4R_r^2r^2 + 4r^4}}$$

This equation may mean more if examples are given; hence two examples at the extremes of normal use are chosen, so that practically all cases will lie between.

I, a 6", $f/8$ mirror with a 1½" prism.
Constants: $Rr = 96.047$
$r = 3$
$T = 1.50$
$n = 1.550$

II, a 12", $f/2.5$ mirror with a 4" prism.
Constants: $Rr = 60.300$
$r = 6$
$T = 4.00$
$n = 1.550$

In Case I, sph = 0.0012". Since the r^2/R correction is 0.047", $\triangle$ sph is insignificant.

In Case II, $\triangle$ sph = 0.0302". This is 10 percent of the r^2/R correction of 0.3000" and is more than sufficient to ruin the image.

Chromatic aberration: This aberration is computed quite simply within 0.0005", thus:

$$\triangle chr = \frac{T}{n_r} - \frac{T}{n_g}$$

where n_r = refractive index for red at 6563 A.U.

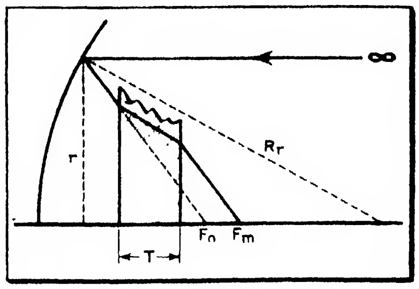


Figure 5: **Sph. Ab. error**

n_g = refractive index for blue at 4359 A.U.

The size of the blurred patch due to chromatism is given by

$$\odot\ \text{chr} = \frac{2rR\left(\frac{T}{n_r} - \frac{T}{n_g}\right)}{R^2 - r^2}$$

For comparison, the diameter of the central diffraction disk of a perfect mirror, without prism, is found by

$$D = \frac{2.44\ R\ \lambda}{4r}$$

where λ = wavelength of light, or 0.00002". A glass frequently used for high-grade telescope prisms is a borate crown in which n_r = 1.514 and n_g = 1.526.

In Case I, $\triangle$ chr = .0077"
$\odot$ chr = .00048"
D = .00039"

and the image is only very slightly affected.

In Case II, $\triangle$ chr = .0200"
$\odot$ chr = .0040"
D = .00013"

Here, the image is enlarged to 30 times normal and results are very seriously impaired.

Chromatic difference of spherical aberration: This error is the least of three axial aberrations introduced by a prism. (The lateral, or Seidel, errors which are functions of the position of the prism and the angle of incidence are not considered because nothing can be done in figuring a mirror to eliminate them while maintaining a sharp central image.) However, if a mirror is to be used for different colors, for different purposes, such as a mirror tested visually and used later for infra-red or ultra-violet photography, this aberration might well be considered with very large jobs. The equation is

$$\triangle Diff. = \frac{T}{n_s} - \frac{T}{n_l} - \frac{T\ (R_r - 2r^2)}{\sqrt{n_s^2R_r^4 - 4R_r^2r^2 + 4r^4}} + \frac{T\,(R - 2r^2)}{\sqrt{n_l^2R_r^4 - 4R_r^2r^2 + 4r^4}}$$

where n = index of prism for shorter wavelength and n the index for longer wavelength.

Compensating for prism: The preceding equations will allow the builder to find the errors which any given prism of good quality will introduce when used with his telescope. The spherical aberration can be eliminated in the figuring but the chromatic error cannot, while the chromatic difference of spherical

aberration can be considered in special cases. If the introduction of a suitable prism would blur the image chromatically more than an allowed tolerance, the prism should be discarded in favor of a flat. If not, the mirror should be figured to a definite amount of under-correction less than $r^2/2R$ in order to have a sharp image. To do this, it is necessary to know the spherical aberration of an uncorrected mirror of the same constants as the mirror to be used. This is given by

$$\triangle F = \frac{R\sqrt{R^2 - r^2} - R^2}{2\sqrt{R^2 - r^2}}$$

The proper radius of the equivalent sphere is that of the paraboloid at the edge, or $R = R_0 + \frac{r^2}{2R}$. Then the proper correction to give the mirror, instead of the usual $r^2/2R$, will be $-2(\triangle F + \triangle\ sph)$. In Case I,

$R = 96.047$
$r = 3$
$\triangle\ sph = +.00120$
$\triangle F = -0.02341''$
$r^2/2R = .04688$
Proper correction $= .0444''$.

In Case II, $R = 60.300$
$r = 6$
$\triangle\ sph = +.03021$
$\triangle F = -0.15000$
$r^2/2R = 0.30000$
Proper correction $= .2396''$

End of Selby's contribution, which ought to have the effect of raising the standards of telescope making. Readers wishing the mathematics behind his formulas may obtain it by asking.

To avoid unnecessarily worrying the very beginner, the lesser effects due to prism error probably will not be likely often to exceed those due to inexperience in mirror making; they

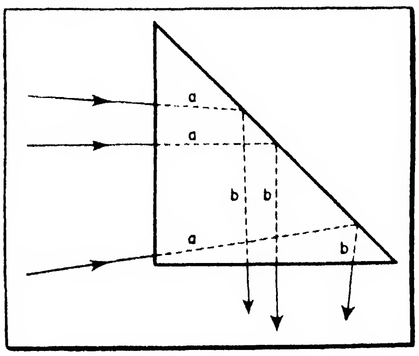


Figure 6: **It equates**

may even help compensate the latter in some instances. For second and subsequent telescopes the worker may to good advantage work out the extent of the prism factor and allow for it if it is found appreciable.

In case Selby's statement that the glass thickness, T, (Figure 1) in a prism equals the width of its cathetus (shorter) face seems puzzling, note Figure 6. The light path, $a + b$, within the prism, is of equal length no matter where the ray strikes it and, the reflection at the back not entering into this particular consideration, the prism therefore equates with a simple, plane-parallel slab of glass, as shown.

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

IN CASE OF FIRE is an eight-page booklet, illustrated in two colors, which describes the use of carbon dioxide for fire extinguishing, and illustrates a complete line of hand and portable extinguishers, hose systems, and re-charging equipment for extinguishers. *C-O-Two Fire Equipment Company, Pyrene Building, Newark, New Jersey.—Gratis.*

DEMOCRACY AND EDUCATION IN THE PRESENT CRISIS is a 14 page pamphlet that emphasizes a need for a greater understanding of democracy and its implications. *Bureau of Publication, Teachers College, Columbia University, New York.—Single copies, gratis; quantities $1.80 per 100.*

2% FOR RESEARCH, by Dr. Karl T. Compton, is an 86-page pamphlet which stresses the necessity of developing new products and processes to keep the United States at work after the defense emergency. It gets down to fundamentals in a manner that shows clear, straight-forward thinking. *National Association of Manufacturers, Committee of Patents and Research, 14 West 49th Street, New York City.—Single copies gratis, quantities 3½ cents each.*

MOTOR-STARTING CAPACITOR MANUAL is replete with practical application data. It includes a listing of electrolytic and oil motor starting capacitors of importance to those engaged in servicing refrigerators and fractional horsepower motors. *Aerovox Corporation, New Bedford, Massachusetts.—Gratis.*

SCIENCE: A STUDY GUIDE FOR TEACHERS contains a discussion of philosophy, current practices, and specific procedures for developing a 12-year program of instruction. *University of Oregon Co-operative Store, Eugene, Oregon.—25 cents.*

THE CHEMICAL DIGEST is 4-page publication issued twice a year. The current issue covers such subjects as the future of textiles, plastics in aviation, chemical detectives, and insurance problems, and includes a number of other short terse items of popular or technical interest. *Foster D. Snell, Inc., 305 Washington Street, Brooklyn, New York.—Gratis.*

EFFECT OF STACK DAMPER SETTING OR FURNACE ON STOKER PERFORMANCE is a 16-page illustrated booklet that is particularly interesting to retail coal dealers, and stoker manufacturers and distributors. It is rather technical in content, having been prepared essentially for those whose work involves getting the greatest efficiency from stokers of all types. Request this booklet on your business letterhead. *Booklet No. 1. The Koppers Coal Company, Pittsburgh, Pennsylvania.—Gratis.*

ATLAS MODERN SHOP EQUIPMENT IS a 72-page catalog which includes complete information on a new line of lathes, drill presses, arbor presses, and shapers. Two new machines are also announced—a compact bench miller and a multiple spindle drilling machine. *Atlas Press Company, Dept. 7, Kalamazoo, Michigan.—Gratis.*

LINK BELT SILENT CHAINS, FOLDER NO. 1894, is a four-page pamphlet that deals specifically with silent chain drives for fractional horsepower duty. Drives for cameras, picture projectors, ice-cream freezers, machine tools, and blowers are among the installations listed. Data are given regarding horsepower per inch of chain width and pitch diameters of wheels. *Link Belt Company, 307 N. Michigan Avenue, Chicago, Illinois.—Gratis.*

COMPLETELY AUTOMATIC MOLDING PRESS is a 4-page brochure which describes in detail a self-contained press for handling themosetting plastics. *Cropp Engineering Division, Warren, Pennsylvania.—Gratis.*

LINCOLN WELDIRECTORY might be termed a combination catalog and reference book on the subject of modern arc welding as it is being applied in a wide range of industries. It covers the subject from fundamentals to a complete series of specific applications, most of which are thoroughly illustrated and described. *Lincoln Electric Company, Cleveland, Ohio.—Gratis.*

DIRECTORY OF ASSOCIATION MEMBERS is a comprehensive list of Consulting Chemists and Chemical Engineers, designed to help all those who need chemical advice or service. *Association of Consulting Chemists and Chemical Engineers, Inc., 50 East 41st Street, New York City.—Gratis.*

LOW COST DIE AND MOLD DUPLICATING is an illustrated booklet which describes a universal duplicator control which can be used with almost any machine tool to permit the reproduction of original models directly in metal. Illustrated are various applications of the unit to turret lathes, planers, shapers, and so on. *Detroit Universal Duplicator Company, 257 St. Aubin St., Detroit, Michigan.—Gratis.*

APPARATUS FOR CHECKING THERMOCOUPLE PYROMETERS is a 28-page illustrated booklet for use by industrial plants and laboratory technicians. It describes the necessity for periodical check of thermocouple pyrometers and equipment with which this work can best be carried out. *Leeds & Northrup Company, 4934 Stenton Avenue, Philadelphia, Pennsylvania.—Gratis.*

Printed in the U. S. A. Press of the Wilson H. Lee Company, Orange, Connecticut.

12568

HUGE quantities of airplanes do not necessarily offset smaller quantities of higher quality, for military purposes. This fact has been definitely established by the war in Europe, as outlined graphically in the article starting on page 278 of this issue. The military ships shown on this month's cover are United States Army P-26's, photographed by Robert Yarnall Ritchie during maneuvers, Perico Island, Pacific side, Panama Canal Zone.

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SCIENTIFIC AMERICAN

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NINETY-SEVENTH YEAR • ORSON D. MUNN, Editor

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MAY • 1941

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OUR Point OF VIEW

M. T. B.'s

OF SPECIAL interest in naval circles are the motor torpedo boats described in some detail on page 281. In the design of these comparatively tiny vessels but little attention is paid to the factor which is of such great import in most naval vessels—armor. Mahogany hulls an inch thick, the whole structure so light and bouyant that it will float even with every water-tight compartment flooded, afford little protection against any projectile larger than that from an air-gun. But an "armor" more invulnerable than mere steel plating is provided; speed and maneuverability. Fastest war vessels on the seven seas, these swiftly striking mosquitos of the navy may be expected ultimately to revise certain ideas in the field of naval tactics.

It must be remembered that these little boats are not exactly an unproved experiment. The United States Navy has been toying with them for several years, has now settled down to a program of building and testing that holds great promise. Other world powers have also built many of them and have found a multitude of uses in many phases of naval maneuvers. For example, it is reported that 18 British motor torpedo boats were particularly effective in the evacuation of Dunkerque. By reason of their shallow draft and great maneuverability not one of the 18 were lost in that action.

Some idea of the tactical uses of these boats is given on page 281. There also will be found a photograph of an American type, showing the machine-gun turrets on deck. The high speed of the mosquitos makes them a poor target for aircraft attack, but if a pilot should attempt to engage one of them, he would find these machine guns to be particularly effective. When a dive-bomber, for example, pulls out of a dive, it is an especially good target for the expert machine gunners on the mosquito, handicapped though they may be by the high-speed, bucking shell on which they ride.

Only a major naval engagement will prove the worth of these tiny war vessels; it is apparent, however, that they can give a particularly good account of themselves in repelling enemy invaders. In such work their speed and ability to maneuver rapidly should place at their mercy the larger, slower, more ponderous vessels against which they would be pitted.

Here is a construction program in which American mechanical ingenuity should be able to show its much vaunted superiority. Past experience should enable us to build the best, fastest, most flexible boats of this type; with these available to both this country and to Great Britain, we will be taking one more step in the right direction.—*A. P. P.*

HYSTERICAL LEGISLATION

COOL, calm contemplation of the job to be done under our national "all-out-aid" policy, exemplified by passage of the lend-lease bill, begets sane, orderly action; undue excitement and failure to think through our problems to their logical conclusions fosters and engenders hysteria. Such unbalance in the country's thinking is at once reflected in councilmanic, state, and federal legislative chambers by introduction and consideration of proposed laws which are often impossible of enforcement, inadequately prepared for the purpose in mind, and even inimical to the public welfare.

Indicative of such hysterical legislation is the present rash of bills proposing registration of what are termed privately owned "sporting firearms." Latest advices are that no less than 20 state legislatures have such bills under consideration and that sooner or later the Congress intends discussion of a similar statute.

The avowed purposes of sponsors of laws to register these privately owned guns are usually two: to remove deadly weapons from hands of subversive groups and individuals, and to "take an inventory" of guns which might prove helpful in national defense.

Contrary to popular belief, firearms are not the chief weapon of the "5th column." Most foreign agents are, first of all, fact finders and news gatherers who uncover information that may be of value to the homeland. Others are propagandists and saboteurs who make use of this information to destroy public property and hinder defense preparations, but not with shotguns and sporting rifles. The conclusion is therefore logical that the only arms registrants would be the law-abiding citizens.

As to "inventory" of the "arsenal" collectively owned by the hunters and target shooters of the nation: Already filed with the state conservation departments today are the names, ages, places of birth and residence, postoffice addresses, and naturalization details of these gun owners, all obtained when the nimrods annually buy their hunting licenses.

True, the files do not show how many and what kind of firearms these men and women own, but it is evident from conservation department records of takes of game and from Department of Commerce statistics relative to the manufacture of guns by the firearms industry that by far the majority of them are shotguns, which have a pitifully negligible value as defense weapons. The deer rifles, varmint guns, and target guns that would be inventoried could *not* be used to equip an army. Ordnance experts state that the conduct of modern war demands simplification of equipment to the extent that one and only one kind or caliber of small arms ammunition should be manufactured, and further, that only one kind of rifle should be used to shoot that ammunition.

Any such inventory of sportsmen's guns would disclose literally scores of sizes of ammunition necessary to fire the rifles and shotguns. Where, then, is the value or need for such a law? Is it not an example of legislation fostered by the excitement of the times? In past periods of national stress cloudy thinking, inadequate investigation, and public hysteria have saddled us with improperly prepared laws, affecting many phases of our national life, that have hindered far more than they have helped.—*A. D. R., IV.*

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of May, 1891)

NAVAL STRENGTH—"We have no navy worthy of the name, and nearly all our seaports are without proper defenses. . . This is a very humiliating position for a country like ours to be placed in. The indifference of Congressmen to the naval defense of the country is astounding. They waste their time over party squabbles, vote billions of money for schemes intended to help bring votes to their respective sides on election day; but as to the immediate creation of an enterprising, prompt and effective navy, which is of vast importance to the country, but little is done, and that little very slowly. . . There should be fifty ships where now there is one. Every harbor in the country should be guarded by efficient sentinels consisting of vessels of high speed, ready for instant action, to maintain and enforce the authority of the republic."

MECHANIZED MINING—"We illustrate a process that has been before the public for some time in California and Colorado, and which is now brought to a practical shape.

The work done by the machinery is of sufficient importance to attract the attention of placer miners, on account of the fine gold it saves, as well as the coarse, and for the new and advanced construction of the entire plant. This plant consists of the Bennett amalgamator, dredge, electric plant, and power house. . . The dredge is arranged to be propelled forward or backward on a screw, or on its own track, by its own power. . . Mounted on the dredge are four electric motors, one of which handles the dipper, another lifts it through its cut, a third swings the dipper to the hopper, while the fourth operates the amalgamator which is upon the rear of the platform. . . The ground upon which this plant has been operating has been variously estimated as paying from 7 to 10 cents per yard, but by the process we have described about 40 cents were extracted for each yard handled."

RAIL SAFETY—"When the railroads of this country had grown to such proportions that the trains had to be run under short headway, it was found essential to adopt some plan whereby the safety of travelers might be made to depend upon something better than the caution of the engineer, and out of that necessity was developed the block signal."

FILTER—"Sawdust and shavings, practically waste substances, are turned to account by M. Calmant, of Paris, for the production of a finely divided vegetable charcoal, which is intended to be applied as a filtering medium, especially in distilleries, where it is said to be capable of filtering forty times its volume of alcohol, whereas the vegetable charcoal of commerce, gradually becoming scarcer and dearer, will only filter about three times its volume. . . Carbonization, which lasts about an hour, is effected in fire clay, plumbago, or cast iron retorts, of about 600 cubic inches capacity."

HYDRAULIC POWER—"The Hartford, Conn., Electric Light Company has nearly completed a notable undertaking for utilizing water power. . . Under contract with the Farmington River Power Company, which owns the dam, about 300 feet long, across the Farmington River, nearly ten miles from the city, the Electric Light Company has erected a station with a full equipment of dynamos, etc. . . Six dynamos are now in operation, supplying 250 street lights. Four more are to be added, which will then generate enough electricity to supply the rest of the street lights."

EXPLOSIVE—"In a recent lecture on gun cotton delivered by Prof. Munroe, of the Torpedo Station at Newport, the lecturer declared that gun cotton, correctly prepared and handled according to directions, was the safest of explosives to use. It was dangerous only when the materials had not been thoroughly purified, or the union of acid and cotton incomplete."

FLIGHT—"The annual meeting of the National Academy of Sciences began at Washington on the 21st of April in the National Museum. A number of interesting scientific papers were read. That of Professor S. P. Langley, of the Smithsonian Institution, on 'Flying Machines,' attracted the greatest attention. . . In summing up Professor Langley said that he did not say that man could traverse the air, but under certain conditions and with our existing means, so far as the power is concerned, the thing was possible. The difficulties would be in getting started, in coming down to the ground again, and in guiding one's self through the air. . . He thought all aerial navigation would pass out of the sphere of charlatanism and into the hands of engineers in a short time, possibly months instead of years."

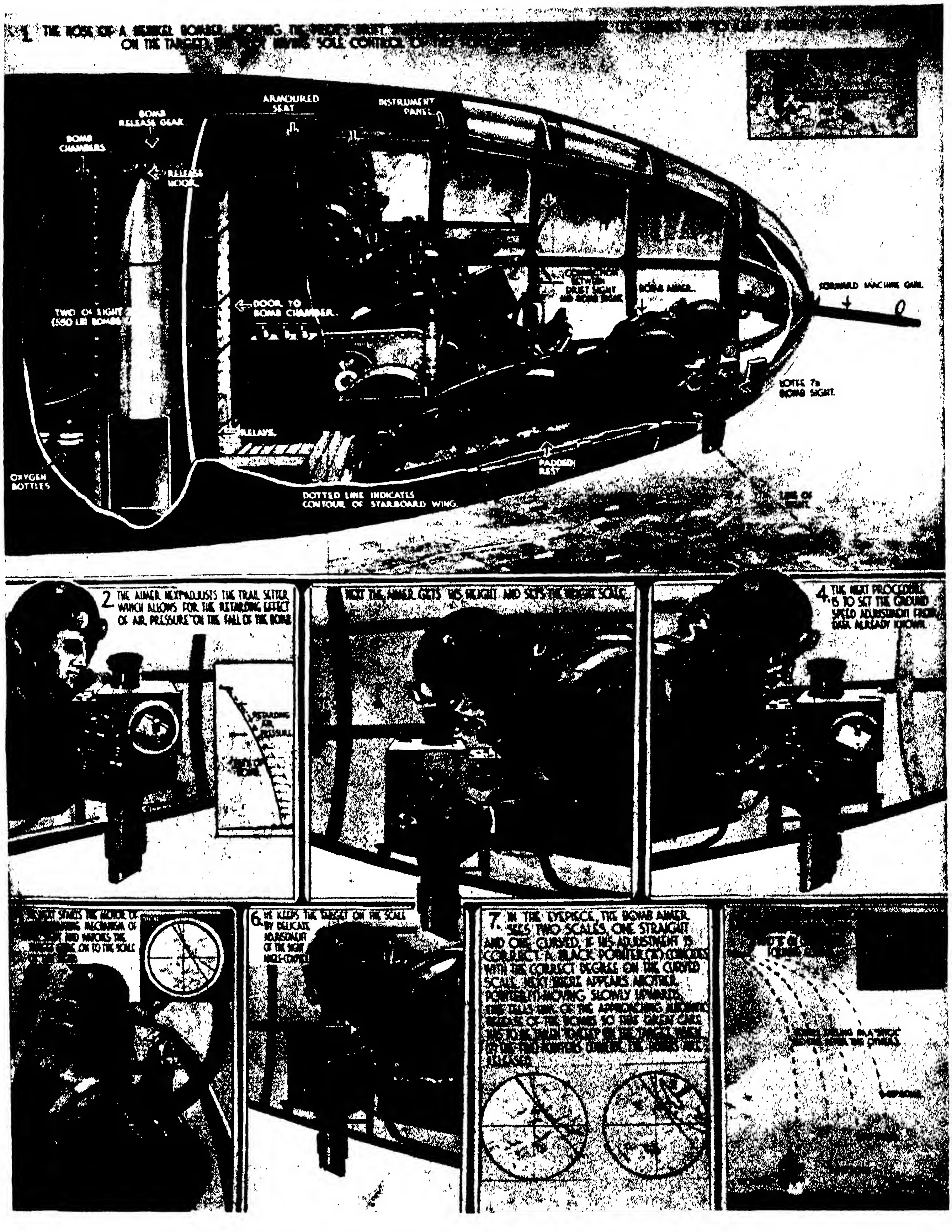
TIN—"The first ingots of tin ever made in California lately arrived in San Francisco from the mines of the San Jacinto estate, Cajalco, San Bernardino County. . . Oil fuel is used in the furnace, this being much cheaper there than coal."

TELEPHONY—"The telephone line between London and Paris went into regular operation on April 2 with much success. The charge is $2 for a talk of three minutes. . . The distance is 297 miles, of which 23 miles are by cable laid under the British Channel."

EFFICIENCY—"Investigations of Langley and Very are of the greatest interest as showing that the attainment of an enormously higher efficiency in the production of artificial light is contrary to no law of nature, and may suggest a system of electric lighting destined to supersede the enormously wasteful methods at present in use."

DETAILS OF A GERMAN BOMB SIGHT

COMPLEX marvel of the modern bombing plane is the mechanical bomb sight which permits more or less accurate placement of bombs from high altitudes. Shrouded in secrecy are even the minor details of the bomb sights of most nations; from official sources, however, G. H. Davis, special artist of *The Illustrated London News*, has obtained data on the German Lofte 7B sight. From these data he prepared the drawings



(*Continued from preceding page*) reproduced on these pages, used here through the courtesy of the magazine mentioned. Most of the details are given in the illustrations. Communication between pilot and bombardier or aimer is provided by telephone or automatic controls. All the pilot has to do is to keep the plane on its course to the target. The rest of the work is done by the aimer, as shown by the picture sequence above. With this sight, the bombs are automatically released when, through the manipulations of the aimer, two pointers on the bomb-sight screen coincide. In one part of the drawing on the preceeding page is shown an open sight on the side of bomb-sight unit. This is for use when the aimer has difficulty in locating the target through the optical system, and is geared to operate parallel with the sighting prism.

97TH YEAR **SCIENTIFIC AMERICAN** MAY 1941

OUR SEARCH FOR THE SUPERNATURAL—II

Did Queen Elizabeth's Spirit Appear?

A. D. RATHBONE, IV

Secretary Scientific American Committee for the Investigation of Psychic Phenomena

THE first of many applications to demonstrate spiritistic powers before the Scientific American Committee for the Investigation of Psychic Phenomena came as a result of the announcement of our search for the supernatural in the April 1941 issue. Rose Ann Ericson, an ordained minister of The Chapel of Eternal Star, and a medium with a large following, addressed Dunninger, Chairman of the Committee, as follows:

"Dear Sir:

"For years I have been aware of your offer to anyone who could demonstrate psychic phenomena, and although I have been reluctant to appear before your committee because I prefer to carry on my work privately among my numerous friends, nevertheless I feel compelled, because of the constant urgings of my friends, to accept your challenge and prove once and for all the absolute reliability of contact with the Spirit World.

"I am willing to appear before your Committee any time, providing the surroundings and atmosphere are satisfactory and in no way interfere with spiritual communications.

"Since a very young girl, I have been gifted with the power of sensitiveness which has been so instrumental in establishing contact with the great beyond. During my sittings it is absolutely imperative that everyone in the room should co-operate to maintain the utmost silence so as not to snap the invisible ray that connects my earthly self with the equally invisible ethereal bodies that send forth their messages to me.

"For some time I have had remarkable communications from Elizabeth, the last of the Tudors, and she is sorely vexed at us earthly inhabitants—and yet with it all—so sympathetic with our problems—she wants to aid us—she is so human in her understanding—she wants to contact the world through me and give them a message—for the sake of a bewildered humanity — she keeps urging me to speak her words. It is difficult to explain in this letter.

"But—I can and will produce definite proof of contact with the spirit of the great Queen—before any legitimate Committee of Truth Seekers—who wish to know and see for themselves manifestation of the Spirit of Queen Elizabeth Tudor. . . May I hear from you? (Signed) Rose Ann Ericson."

PSYCHIC RESEARCH

● **Scientific American, in collaboration with The Universal Council for Psychic Research, offers $15,000 to any medium who can produce a spiritistic effect or a supernatural manifestation under the rules and regulations published on page 210 of our April 1941 issue.** ●

In view of Madame Ericson's reference to her contacts with the spirit of Queen Elizabeth, the Committee for the Investigation of Psychic Phenomena instituted a search for surroundings and atmosphere which would most favorably lend themselves to communication with spirits of the Elizabethan Era. It was learned that some years ago Mr. William Randolph Hearst had purchased and brought to the United States the wainscoting from "The Old House," previously known as "The King's Lodging," of Sandwich, England, the latter designation being derived from the fact that Henry VIII stayed there many times. The present interior embellishments, however, date from the Elizabethan era, the upper room, called "The Queen's Bedchamber," having been specifically prepared for Queen Elizabeth's visit in 1572.

The psychic possibilities of such a room, which, fully reconstructed, forms a part of the Hearst collection of objects of art now on display at Gimbel Brothers' New York store, were at once apparent to Dunninger, who called them to Madame Ericson's attention. Receiving her approval, arrangements were made through the courtesy of Dr. Armand Hammer, whose organization, The Hammer Galleries, has been entrusted with the sale of the Hearst collection. With the cooperation of Gimbel Brothers, a seance was arranged for the evening of Monday, March 17.

AS DUNNINGER, whose 20 years of research into the occult field have so ably prepared him for his present work, clearly stated on that night to the assembled representatives of the New York press and other periodicals, as well as to members of our Psychic Committee and their guests: "The seemingly impossible of today is the commonplace of tomorrow."

"All of us present," said Dunninger, "are seeking for knowledge, for something we hope to find in the future. There is here no brief against or for any religion or cult. It is a scientific effort toward a background of the psychic, toward a basis of fact on the part of a research committee which is not interested in trickery or subterfuge. What we do seek is the truth about psychic phenomena.

SCIENTIFIC AMERICAN
Committee for
The Investigation of Psychic Phenomena

A common interest in the subject of psychic research characterizes these men from wide fields of endeavor who have consented to act as an impartial committee to supervise and conduct our investigation of the spiritistic realm.

"Do ghosts, spirits, vampires, or phantoms return to this world from another, of which we know nothing? In our effort to find basic facts, if any, underlying so-called spiritistic phenomena, mediums reputed to possess the kind of powers we desire to study can be of great assistance. Thinking people want this question answered once and for all. The public at large desires to know whether the entire psychic situation has a substantial foundation, or if it is merely a gigantic hoax.

"This medium, Madame Ericson," declared Dunninger, "has a wide-spread and excellent reputation. However, nothing has been done to hinder trickery, should it exist in the demonstrations to come. She has not been disrobed to determine whether she may have concealed on her person mechanical means for producing occult effects. What will happen in the seance that is to follow," he concluded, "no one knows."

Before the lights were extinguished, Madame Ericson requested complete quiet and asked that guests refrain from smoking. She stated that she could guarantee nothing, but that she intended to try to communicate with the spirit of "Good Queen Bess." With that the lights went out, and doubtless all present felt that if only the ancient wainscoting from old England could talk, through the spirit of Queen Elizabeth, or even some of her contemporaries such as Henry Hudson, or Sir Francis Drake, Ben Jonson, or William Shakespeare, it would be, to say the least, an amazing display of psychic powers.

After the guests had sat in complete darkness for several moments, with accompanying phonographic music, there came an indistinguishable muttering, presumably from Madame Ericson. Next, the medium's voice was heard, strained and unnatural. She said, "Keep your eye on Russia," and with that some witnesses later claimed they heard rappings from the table at which were seated Madame Ericson, Dunninger, and A. Paul Peck, who is a member of the Universal Council for Psychic Research, as well as a member of the Scientific American Committee. [Throughout the entire demonstration Messrs. Dunninger and Peck each held one of Madame Ericson's hands.—*Ed.*]

Then the medium said: "Many there are today who doubt, but I have every reason to believe that my country will be saved and that Hitler will be demolished." [Presumably the spirit of Queen Elizabeth voicing its opinions, although there was no specific mention of any spirit up to this moment—*Ed.*] "A peak is reached between April and May," continued the voice of Madame Ericson, "and the war is not over. No, this war is not over. There will be a period of five years of turmoil from ocean to ocean, with brother against brother, country against country."

At this juncture the medium, still conversing in a strained, unnatural voice, stated that a figure was materializing before her, and asked whether any in the audience could see the apparition. A woman, identified later as a member of the medium's belief, replied in broken English that she could see the spirit.

Dunninger, alert to seance developments, asked the woman to describe what she saw. The reply was that the spirit, as seen by the member of the Chapel of Eternal Star, stood in front of the medium's table; that it was a feminine figure, about five feet, eight or nine inches, tall; that it wore a gray dress, but no hat. In response to Dunninger's


These two flashlight pictures, taken, as were others, at the exact moments designated by the medium, fail to indicate materialization of spiritistic presences of either Queen Elizabeth or the Earl of Essex

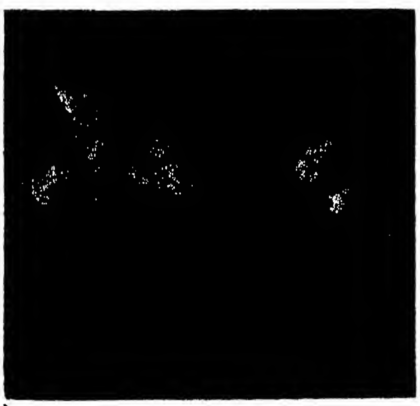
question as to the color of the hair, the witness said she could discern no color. By way of further description of what she said she saw, this woman claimed that the spirit had rather high cheek bones and deep-set brown eyes. Madame Ericson added that she thought the spirit was greatly worried and looked extremely tired. In a low voice she then said to Dunninger: "Tell them to take pictures." Immediately two flash bulbs were set off with dazzling brilliance.

Climaxing this performance, Madame Ericson next said she could see the spirit of a man, that he was tall and handsome, dressed in Elizabethan style—that he was no less a person than Robert Devereux, second Earl of Essex, an in-and-out court favorite of England's Virgin Queen.

At this point Madame Ericson's voice seemed to be pitched slightly higher. Her words, although scarcely audible, came with a more rapid tempo. Suddenly rappings were distinctly heard by some at the front of the room and Dunninger exclaimed: "There are rappings coming from the table! Some of you probably cannot hear them, but they are audible. Peck," he continued, "do you feel a vibration?"

The answer was affirmative, and in view of the fact that Messrs. Dunninger and Peck were still each holding one of the medium's hands, it is obvious that the rappings could not have been produced through physical contact of her hands with the table.

Just then Dunninger spoke, rather sharply. "There is a substance visible at her lips. Can anybody see it? I think it is indicative of an ectoplasmic demonstration. Yes, it is! It is ectoplasm! Can you see it?"



Shortly after ectoplasmic demonstration, medium collapsed

Flashlight photograph, with camera and all eyes focused at point near table where Madame Ericson claimed spirit of Queen Elizabeth appeared

A momentary pause in absolute quiet followed this announcement as it was apparent that all eyes were straining through the darkness for a glimpse of the psychic phenomenon known as ectoplasm. And then, dramatically, the seance ended. Dunninger cried out, "Here, what's the matter with her? The lights, somebody, the lights!" Instantly a photographer's flash bulb was set off, followed by the turning on of large dome lights in the ceiling.

As the audience blinked in the sudden glare, it was seen that Madame Ericson had fallen forward onto the table. Dunninger and others sprang to her assistance, straightened her in her chair. Her head slumped back and her eyes were closed. Water was called for and she was revived, but she still appeared in a trance-like state.

A canvass of those present indicated that several, including Dunninger, had seen evidence of an ectoplasmic demonstration, but that only two persons, both members of The Chapel of Eternal Star, had seen the manifestations of the spirits which, according to Madame Ericson, had been those of Queen Elizabeth and Essex.

At an immediate conference of the members of the Scientific American Committee for the Investigation of Psychic Phenomena who were present it was determined that the request of Madame Ericson for another sitting would be granted.

At the conclusion of the evening's seance, Dunninger said: "The emission of ectoplasm from the medium's lips was very slight, but it was distinctly visible for a few seconds just before one of Madame Ericson's followers wiped it away with her handkerchief. It is not surprising that the ectoplasm was not discernible by most of you, as it was a demonstration of exceedingly minor character, and for that reason could hardly be said to be visible to the average naked eye."

"As in the case of the spirits of Queen Elizabeth and Essex, which I did not see," continued Dunninger, "and which were discernible by only two of those present, I trust the pictures, taken at the suggestion of the medium, will show us what our visual senses could not detect. In summation of the evening's demonstration," he said, "I would say there was nothing visible to the naked eye which requires explanation. Everything will depend on the pictures, and we can only hope that the photographers have been fortunate enough to secure some unmistakable evidence of either the ectoplasm or the spirits." [Subsequent development of the negatives exposed during the seance failed to produce any photographic evidence of psychic phenomena, although, as will readily be seen from facial expressions, the timing of the pictures with the reported appearance of the phenomena must have been as accurate as possible.—*Ed.*]

What Light For Industry?

Relative Freedom from Heat and Glare, Plus Color Control, In Fluorescent Tubes

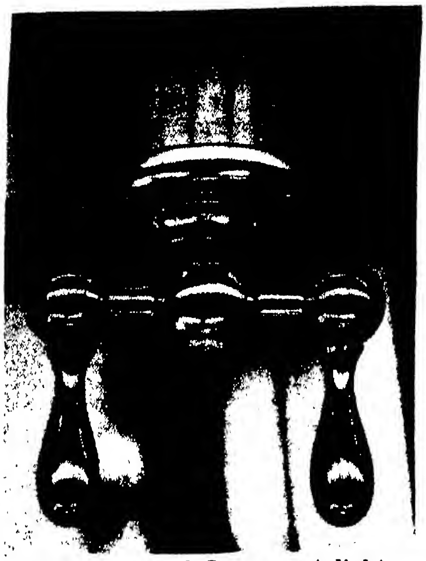
A. P. PECK

IF, WHEN fluorescent lighting emerged from the laboratory four years ago, there was any suspicion that here was just another stunt which would never become practical, that suspicion has completely vanished by now. Industrial applications of these tubular lamps without filaments have increased to such an extent that, it is estimated, 25,000,000 of them will be manufactured during 1941, approximately three times as many as were made during 1940. In the face of these figures it is easy to visualize this particular part of the lighting industry as one of the nation's fastest growing industrial infants.

Fluorescent lighting offers many desirable qualities that recommend it especially to application in factories, offices, stores, and so on. Its efficiency is high, it is relatively cool as compared to incandescent lighting, there is little glare, after-images are absent even when the worker has to look directly at the light source for a considerable period of time, and, by the selection of the proper tubes, lighting with a wide variety of colors may be obtained directly without the use of filters or other supplementary means of color modification. Of these qualities more later; first, let's see just what fluorescent lighting is and how it works.

In the fluorescent tube, advantage is taken of the phenomenon of an electrical discharge through gas. This principle is by no means new and has been widely used in other lighting applications, of which neon and mercury-vapor tubes are probably the best known examples. But in the fluorescent tube the discharge itself does not give rise directly to visible light; in fact, every effort has been made to reduce visible light of the discharge to a minimum and to bring to a maximum ultra-violet generation at one specific point in the spectrum—at the 2537 angstrom line, to be exact. The reason for this is that ultra-violet radiation of this wavelength is the most efficient for obtaining the end result of fluorescent lighting.

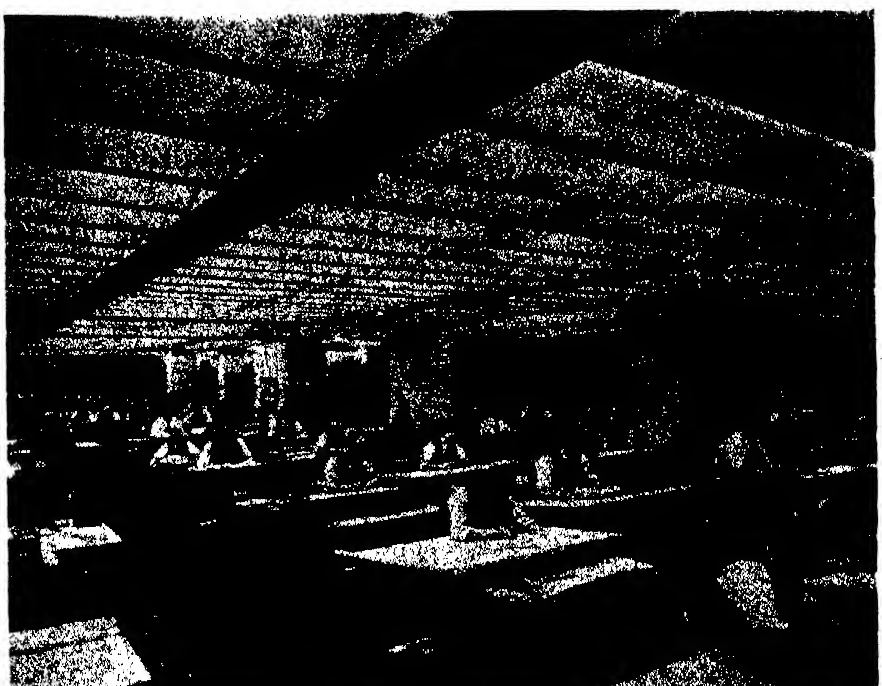
Within the tube of a fluorescent lighting unit is a drop of mercury and a small amount of argon gas to facilitate starting. Coating the interior wall of the tube is a material—phosphor is the general term applied to these coating materials—which has the property of glowing when acted upon by ultra-violet, thus giving forth visible light of a color that is determined by the particular phosphor used. Behind this process is a highly complicated physical explanation that can briefly be reduced to the following statement: The phosphors used have the property of absorbing radiated energy at one wavelength and of reradiating energy in a continuous band of visible wavelengths. Thus the ultra-violet of wavelength 2537 is absorbed by the phosphor and the resulting reradiation is in the visible part of the spectrum, giving useful light at a relatively high efficiency and with little heat.



Large area of fluorescent light sources reduces glare on scales

As was mentioned above, there is a small amount of mercury within each fluorescent tube. This metal was selected because an electrical discharge through mercury vapor results in high-efficiency production of ultra-violet radiation in the region best suited to activation of the phosphors.

One of the difficulties of fluorescent lighting is the fact that the tubes will not start when cold; it is not sufficient to apply current to the two terminals as in the case of incandescent lamps. Something more is needed to create the elec-



Fluorescent tubes in angular reflectors illuminate a drafting room

trical discharge that results in light. In each end of the tube, therefore, there is placed a heating electrode; externally is an automatic starting switch. The circuit is so arranged that when the current is turned on, it flows through the two electrodes in series, generating heat that vaporizes the mercury, thus providing a path for the electrical discharge through the tube. When this condition is reached, the starting switch automatically disconnects the current from the heaters, but permits it to continue its path through the gas. Included in the circuit is a choke coil which limits the arc or discharge curent.

ONE type of starting switch, made by Mazda lamp manufacturers, uses a bimetallic strip in the following manner: When the current is turned on a glow discharge is set up between the bimetallic strip and a center electrode in the starting switch. This discharge creates heat that causes the strip to expand and make contact with the center electrode, thus completing the circuit through the heating electrodes of the fluorescent tube. When this contact is made, the glow discharge ceases and the bimetallic strip contracts and breaks the circuit in the starting switch. An inductive kick from the choke now starts the discharge through the fluorescent tube. From this point on in the cycle the voltage at the starting switch is insufficient to set up the glow discharge and hence the switch is inactive and consumes no current during lamp operation.

Now to get back to the qualities of fluorescent lighting mentioned in the second paragraph of this article:

Installing industrial lighting fixtures for fluorescent tubes

Overhead fluorescent lighting, plus individual units on assembly benches

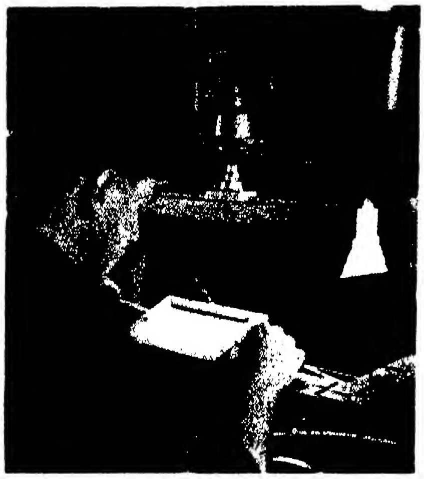
It is easy enough to make statements regarding efficiency, as compared with more conventional lighting, and let it go at that. For example, it can be said that a daylight fluorescent in the 40-watt, 48-inch size, is almost three times as efficient as the familiar 60-watt filament lamp, or that the white fluorescent is of even higher efficiency. But that is not the whole story. When it comes to replacing existing lighting installations with fluorescent lamps, there enter such considerations as amount of rewiring, quantity and color of light required for the job in hand, and other factors of economy that complicate the problem. Even though there has been a drastic reduction in retail prices of fluorescent tubes since their introduction, first cost of installation still plays an important part.

The following statements by a Westinghouse lighting engineer give a hint to the problems involved. "The general lighting of factory areas can usually be done most economically by means of filament lamps or mercury vapor lamps. This is particularly true for high mounting. Where machines or assembly lines are in long parallel rows, the fluorescent white or daylight lamps may be applied successfully. . . . Single units mounted over inspection tables are particularly good for inspecting metal parts. The large diffuse source facilitates the detection of imperfections and makes the reading of gages more precise. . . . The same unit may be used over drafting tables with excellent results. Freedom from shadows, absence of unpleasant radiated heat, and light of daylight quality combine to make this type of lighting increasingly popular."

It will readily be seen, therefore, that any attempt to generalize regarding the efficiency of fluorescent lighting for a particular application, or its desirability in a wide range of industrial uses, might result in misunderstandings. Only when all factors are considered and weighed in their proper proportions can definite recommendations be made.*

OPERATING temperatures of light sources are of interest in two main respects. First, where temperature of the source is high, it is evident that much of the energy being consumed is appearing as heat rather than light. This phase, of course, bears on the subject of efficiency just discussed. If the temperature of a light source is low in relation to the light delivered, it is evident that efficiency is high. High temperature, in turn, indicates low efficiency. Everyone is

*Readers who desire more detailed data on the applications of fluorescent lighting in industry will be referred to comprehensive sources if they will address the writer at 24 West 40th Street, New York, N. Y.



Fluorescent lighting fixture for inspection of metal strip. Inspector sees both sides of strip by use of the mirror shown

familiar in a general way with the high temperature quickly reached by an ordinary incandescent light bulb, if for no other reason than the memory of trying to remove one from its socket immediately after it burned out! On the other hand, when a fluorescent tube is operating at a room temperature of from 70 to 80 degrees, the glass tube itself will reach a temperature of only 100 to 120 degrees—relative coolness for a light source.

The second point of interest in light-temperature ratio is the effect that high-temperature light sources have on surrounding objects. Persons whose work demands that they be close to a bright light source may be forced to work under uncomfortable conditions when incandescent lighting is employed. In such cases, fluorescent lighting can have very definite advantages. Even where the source is not close to the work, but is of high intensity, the heating effect of incandescent lighting on the whole room can be marked, especially in warm weather. The generally accepted figure of comparison between fluorescent and incandescent lighting is that the sensation of heat from fluorescent lamps is, roughly, only one quarter that from filament lamps for the same amount of light delivered.

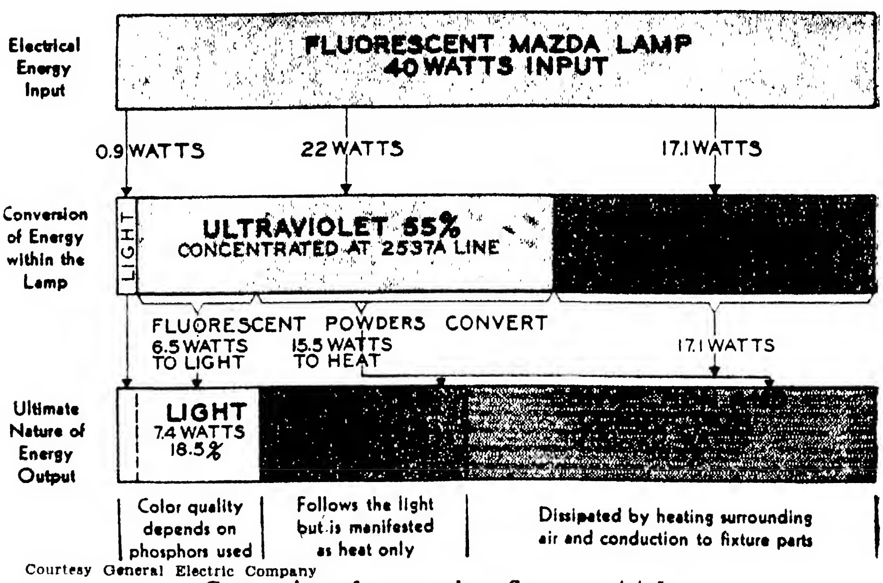
This last statement is based on the following facts: While a kilowatt-hour of electrical energy represents a heating effect of 3414 BTU's, regardless of how consumed, the lesser sensation of heat from fluorescent lamps is accounted for by the fact that only about 50 percent of the energy is radiated as heat, compared to 80 to 90 percent for gas-filled filament lamps. Because light production efficiency of a fluorescent lamp is double to triple that of filament lamps, and because the radiant heat is approximately half that of a filament lamp, the rough figure of one quarter the sensation of heat, given above, is reached.

While dealing with the temperaature characteristics of fluorescent lamps, it is interesting to note that the temperature of the surrounding air has an effect on the operation of the lamp itself. At low temperatures the mercury condenses out and the production of ultra-violet is reduced. At high temperatures, the vapor pressure within the tube is increased and some of the ultra-violet radiation is shifted to longer and less desirable wavelengths. There is also an increased re-absorption of the ultra-violet radiation at 2537 by the mercury vapor. In the case of low temperatures, the effects can be offset to a great extent by enclosing the lamps; at high temperatures, air movement may help to compensate.

Undesirable glare may be produced under either natural or artificial light when direct or reflected light from the source reaches the eye without sufficient diffusion. Glare has been defined, by a General Electric lighting expert, as "light out of place." It causes the pupil of the eye to contract, thus restricting the amount of useful light that enters the eye. It gives rise to nervous tension and fatigue and thus, especially in the industrial plant, paves the way for reduced efficiency and for accidents.

When light comes to the work from a concentrated source, as in incandescent lighting, the possibilities of glare are manifold, resulting in a number of expediencies in the form of light diffusing means to reduce glare. In the fluorescent lamp, on the other hand, the light source is of large area and relatively low intensity. Hence there is less possibility of glare, although even here it is usual to incorporate some shielding means in the lighting fixture. It is notable, however, that little or no "after-image" effect is found even when the eyes are exposed to the direct light from a fluorescent tube. This is of particular advantage in industrial plants where workers have to change their angle of vision constantly and cannot always avoid looking directly toward the light source for a few seconds at a time. Airplane assembly is a case in point; workers on the final assembly job may be bent over some part of the operation one minute and working on an over-head unit immediately after. The diffused light of fluorescent tubes is of particular importance in such instances.

The wide range of colors available in fluorescent tubes—the color is a property of the phosphor and is not due to colored glass—gives these tubes a multitude of uses from severely practical to highly ornamental. Colors that can now be obtained include "daylight," white, blue, green, pink, gold, and red. (The last two do use colored glass to increase the saturation of the resultant light.) The daylight and white types find the greatest application in industrial lighting, although the other colors have their



Courtesy General Electric Company

Conversion of energy in a fluorescent tube

own usefulness for special purposes.

Brief descriptions of two outstanding industrial applications of fluorescent lighting will serve to indicate present applications and future possibilities. A paint company in Ohio is making use of these light sources in their color matching room where samples of lacquers and enamels are checked against standards. The installation consists of 24 of the 36-inch tubes and 12 of the 18-inch tubes. The lamps are backed by Alcoa sheeting, used primarily because of its non-selective reflecting properties. The lamps are in three circuits, each circuit providing approximately 175-footcandles on the samples, making possible a maximum of about 500-footcandles. The lowest light level—175 footcandles—is used for matching whites and other colors of high-reflection factor. The second level is used for colors of medium-reflection factor, and the high level of 500 footcandles for blacks and other low-reflection colors. This type of installation is well adapted to other inspection problems with materials which exhibit a surface sheen that interferes with ordinary visual inspection. It also holds possibilities for production inspection on conveyor belts.

Underway now is the installation of 35,000 of the 48-inch, 40-watt tubes in an airplane plant in California. These lamps, mounted in open-end fixtures arranged in parallel rows 40 feet above the floor, will provide workers with an average light level at their work of 45 footcandles. This level is stated to be more than four times that on desks in the average office today.

Recitation of applications of fluorescent lighting, installed and underway, could go on for pages and would include examples from almost every field of endeavor. From cotton mill to drafting room, from machine shop to printing plant, would go the list, indicating that fluorescent lighting is finding its place in the American way of doing things. That it is the last word in lighting, or that it will completely replace other forms are statements that should not lightly be made. There is no doubt that better, more efficient lighting systems will come out of the laboratories in the future, and that each of them will have advantages and disadvantages. In the meantime, however, fluorescent lighting will progress, side by side with other forms of lighting, doing its part to give to industry the better lighting that it must have if it is to function at highest efficiency.

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New Porcelain Insulation

High Mechanical Strength and Electrical Resistance in Die-Pressed Material

H. T. RUTLEDGE

New and better insulators are of prime importance to the electrical industry. No electrical instrument or installation can be better than the insulating materials used at strategic points to keep the current flowing in the proper channels and from wandering off the straight and narrow path. Not only must these materials have high electrical resistance; they must also be mechanically strong to prevent undue breakage when subjected to sudden stresses. And as better insulating materials are developed, the way is opened to increase efficiency of electrical work.

Pouring the dampened Prestite mixture into the forming die

High pressure is used in this hydraulic press in which the damp clay mixture is formed into high-strength non-porous insulators for a wide range of applications in electrical work

Porcelain is one of the materials that has been widely used in high-voltage insulators, its value being dependent upon its lack of porosity and the mechanical strength that could be made inherent in its structure. Highly porous porcelain has poor insulating qualities; the less porous the porcelain can be made, the better it will do its job. Incidentally, it is usually found that hand in hand with decreasing porosity goes increased mechanical strength.

A handful of clay used in making the new electrical insulating material, as described on this page, and a formed fuse box

Both dry and wet methods of making porcelain have been employed in the past for making high-voltage insulators. In the former, dry clay is molded into the required shape and then glazed and fired.

A flashover test of Prestite insulators, in which is applied seven times the potential for which they are designed

In wet methods, the clay, containing as high as 31 percent of moisture, is either cast or pressed to shape and then finished.

In a new porcelain process, the clay to be processed is moist, being neither wet nor dry. In this state it is molded in steel dies under tremendous pressure. Because of the method of handling, this new porcelain, called Prestite, can be molded into shapes as intricate as are possible with dry molding, but the resulting material shows mechanical and electrical strengths that heretofore were impossible of attainment. Finished Prestite insulators, according to E. H. Fischer, Westinghouse engineer who developed the process, are non-porous and consequently erect a strong barrier against the flow of electricity. Because of this increased insulating property, the new material can be made thinner to perform insulation work that formerly required much larger and thicker porcelain insulators.

With the new process it is possible to turn out one Prestite insulator every three minutes as compared with two or three a day per mold in the old wet casting system. The Prestite body mixture is simply poured into a die and molded by a hydraulic press. Drying takes 20 percent less time than with cast or plastic porcelain, and the shaped Prestite form requires a minimum of trimming before being glazed and fired.

For the present this new porcelain will be manufactured only as insulating parts for high-voltage equipment such as fuse boxes, switch bases, lightning arrester caps, and suspension insulators. It is expected that the field will later be extended to cover all high-voltage insulators within its scope.

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INSPECTION

Gamma Rays Pierce Steel, Show Defects

PIN-POINT "power plants," minute grains of radium sulfate, are at work inspecting national defense equipment as it is rushed through production in the Westinghouse Steam Division Works. The mites of radium salt produce gamma rays potent enough to penetrate 10 inches of steel, registering the metal's internal condition on film. Radium sulfate is used to examine parts of steam turbines, propulsion gears, and auxiliary apparatus for United States Navy fighting ships. The inspection process, worked out by Navy engineers and research scientists, also is being applied to commercial power equipment.

As a step in speeding up national defense work, 500 milligrams of radium sulfate have just been acquired. This brings the supply at the plant to 825 milligrams, a strange tool of science about half the size of a boy's small marble. A pound of radium sulfate would cost about $11,500,000, would be about the size of a tennis ball.

In radium sulfate, the atoms split spontaneously. This perpetual disintegration generates gamma rays which can pierce the hardest steel. Flaws in the metal appear on the film as dark areas. The rays are able to reach the film with greater intensity during an exposure period through flaws than through solid metallic structure.

Gamma rays revealed flaw areas; welding fuses in the new metal

Air bubbles and impurities in metal parts of steam and ship propulsion equipment are ferreted out to prevent later development of any weakness. Turbine steel must withstand steam temperatures up to 1000 degrees, Fahrenheit, hot enough to melt zinc. The steam hurtles through the machines at pressures as high as 1500 pounds per square inch. The steel structure of a turbine steam chest resists expanding forces which are equivalent to the weight of the largest railroad locomotive.

Lead-lined container used for transporting radium sulfate; direct handling is dangerous

When a piece of equipment is brought into the laboratory for inspection, a technician fishes a radium capsule out of a sunken safe. The walls and bottom of the safe are four-inch slabs of lead. Inside it is a block of lead with small wells to hold the radium sulfate containers. A lead lid locks into place over the safe.

The capsules are suspended on a midget rigging placed within or beside the metal being tested. As many as 20 films have been taken in the Westinghouse laboratories at the same time. A belt of film can be placed around circular pieces of metal, such as pipe. These films

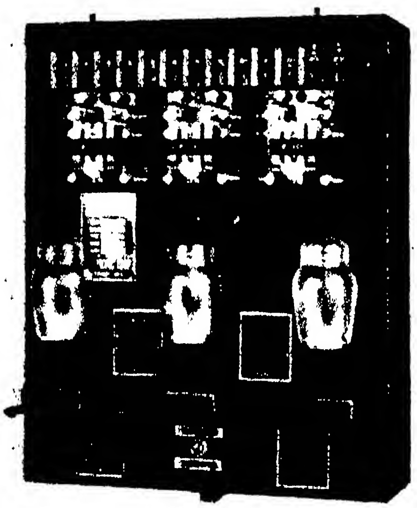
register gamma rays from a single radium sulfate source fixed in the center.

Exposure times vary from a few minutes to 48 hours. Time of the exposure is gaged by using a special slide rule, developed for the purpose by Navy engineers.

TIMER

Eliminates Pressure Switch in Spot Welding

Designed to eliminate the necessity of an air or hydraulic pressure switch in resistance welding and to provide accurate timing control for any air-operated stationary or portable single or multi-spot welder, a new electronic tube type timer has been added to the line of timers and controllers manufactured by Weltronic Corporation.



Four dials adjust "squeeze" "weld," "hold," "off" times

Featuring a minimum of moving parts as well as eliminating the need of a pressure switch, the Model 75 insures a minimum of maintenance costs with down time being virtually eliminated, it is claimed.

Using a repeating timer to eliminate the need of a pressure switch requires one additional timing function. The four adjustments required are: "Squeeze" time, "weld" time, "hold" time, and "off" time. The "squeeze" time is the interval between the instant the initial welding pressure is applied and the welding current is "on," which allows sufficient time to permit the full welding pressure to build up before welding current is applied. Thus, the timer will compensate for the effects of lowered room temperatures or extreme distance from pressure switch to welder and should insure uniform performance and better quality welds.

The four adjustments are made by "dialing" the control knobs on the front of the panel. The wide range of optional time selection from 2 to 30 cycles in close steps is sufficient to provide accurate timing for almost any stationary or portable, single or multiple spot welding operation where air or hydraulic pressure is used. Single weld or automatic repeat operation is optional to suit the work. A toggle switch on the front of the panel permits rapid change-over as required.

Timer is mounted complete in a compact cabinet to facilitate moving with a portable unit, or built into a stationary welding machine as needed.

INDUSTRIAL FILM

New Form of Synthetic Has Many Uses

The development of a method of processing Koroseal, a synthetic thermoplastic material, into a transparent and highly durable film with wide industrial application, is announced by the B. F. Goodrich Co. The film development is the seventh major product field invaded by Koroseal, the synthetic created from limestone, coke, and salt, according to Dr. H. E. Fritz.

"Quite unlike other films," Dr. Fritz said, "Koroseal film is resistant to outside exposure—sun, oxygen, and extremes and changes of temperature. In addition, the new film is extremely water and moisture-resistant, our tests have shown."

Glass-clear and highly flexible, the film is now being produced in gages ranging from one-thousandth of an inch and up. It is made in a variety of colors in transparent, semi-transparent, translucent, and opaque forms.

Of limestone, coke, salt, water

While the chief uses of the film are in waterproofing and packaging materials, its chemical inertness, flame resistance, and electrical properties make it valuable for laminating chemical containers for holding acids and corrosives and for insulating fine electric wire and cable. Other more obvious adaptations are rain-wear garments of all kinds, shower curtains, window draperies, aprons, refrigerator bags and food coverings and other applications where flexibility and moisture-resistance are desired.

TOOL ROOM LATHE

Has Telescopic Taper Attachment

A new tool room lathe announced by the South Bend Lathe Works has a number of features which save time on tool room operations. This 16-inch swing underneath belt motor driven precision lathe, Series S, is made in 6, 7, and 8-foot bed lengths, having distances between centers of 34, 46, and 58 inches. The headstock has a capacity of 1⅜ inches through the spindle and takes collets up to one inch capacity.

New control arrangements save time and effort; reduce fatigue

The arrangement of controls on this new lathe saves time and effort, reducing operator fatigue and assuring maximum production. Large diameter hand wheels make possible precision adjustments on close tolerance work. Adjustable micrometer collars on the cross feed screw and the compound rest

screw are large in diameter with clear-cut, easy to read graduations.

Tool room attachments supplied with the lathe include hand-wheel type draw-in collet chuck, telescopic taper attachment, micrometer carriage stop, thread dial indicator, and chip pan. An electric grinding attachment, milling attachment, and other attachments, chucks, and accessories are supplied to order.

The enclosed underneath motor drive provides eight spindle speeds ranging from 21 to 725 revolutions per minute. Vibration-free operation at high spindle speeds is achieved by using a direct belt drive to the balanced cone pulley and spindle assembly.

A quick change gear mechanism provides a series of 48 power longitudinal carriage feeds .0015 to .0841 of an inch, a series of 48 power cross feeds .0006 to .0312 of an inch, and a series of 48 right and left hand screw threads from 4 to 224 per inch.

METALLIZING

New Type Gun has Controlled Feed

THE process of metallizing, in which metal wire is melted and then atomized and sprayed on any base metal, is finding increasingly wide uses in various industries. It has been applied to the restoring of worn machine parts, such as bearing surfaces, shafts, pump

Controlled feed for uniformity

rods, and so on; to repairing defects in castings; and for the application of corrosion resistant coatings of zinc, lead, tin, and other metals. Aluminum coatings so applied have proved successful in retarding heat corrosion or oxidation on engine exhaust manifolds, furnace parts, and similar equipment.

In the new type of gun illustrated in these columns, the design has been so worked out as to give uniform and steady wire feed regardless of fluctuating conditions that affect the operation of other guns. In previous guns the wire feed has been controlled by regulating the flow of air to the air turbine which provides the power for feeding the wire. This has the disadvantage of considerable speed fluctuations under varying load, requiring constant regulation by the operator. In the new type of gun, with its "controlled power unit," the speed of the wire is regulated by means of a governor which allows full power input at all times and eliminates speed fluctuations under varying loads.

OVERLOAD DEVICE

Flexible Bearing Acts in Novel Manner

POSSIBILITY of the use of a flexible bearing as a low-cost overload device for various types of power-driven equipment subject to only occasional overload of short duration is suggested by the operating characteristics of the "Torflex" flexible bearing.

In its capacity as a flexible coupling capable of compensating for parallel or angular misalignment, the bearing itself would transmit power and so serve as overload device at the same time.

Although originally designed and used as a vibration dampener, shock absorber, and noise eliminator, capacity tests made in the laboratories of Harris Products Company show that, when the bearing is greatly overloaded, the mechanical bond between the rubber wall and the inner sleeve will slip intermittently. This slippage is momentary, however, and immediately the overload is reduced, the rubber wall resumes its grip on the inner metal tube with its original load capacity. Under overload conditions the rubber (or neoprene) wall is twisted. The twisting or "winding up" of the rubber has the effect of contracting the thickness of the rubber, thus permitting slip to occur.

Due to the method of manufacture, there is a mechanical rather than a chemical bond between the rubber and the inner or outer metal walls. In the process of manufacture, rubber is stretched between the inner and outer walls and then permitted to seek its original position or state. The forces exerted by the rubber in so doing exert a high capacity mechanical bond which is present under all operating conditions found in normal service, except elevated temperatures.

Use of the bearing as a clutch is not recommended since the heat generated by more constant slip

The type of flexible rubber-and-metal bearing that can be used as a temporary overload device

would not only destroy the holding force exerted by the rubber but the rubber itself.

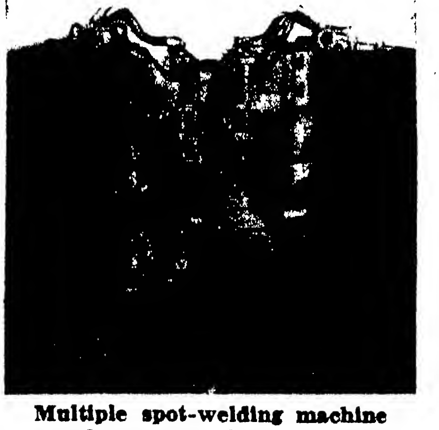
Neoprene can be substituted instead of rubber where required and, if corrosive conditions dictate, stainless steel for inner and outer sleeves or brass or graphited bronze sleeves are also combinations that are available in standard sizes.

WELDING SPEEDS UP

Multiple Spot Machines Increase Production

MADE necessary by the defense housing program and having a combined production total of 2400 lineal feet of Stran-Steel members per hour under present operating methods, two new multiple-spot welding machines designed and built by Progressive Welder Company were recently placed in operation at the Jackson plant of the Stran-Steel Corporation.

The new equipment, which is sufficiently flexible to handle numerous combinations of sizes, shapes, and so on, places the fabri-



Multiple spot-welding machine speeds mass-production efforts

cation of such material on a mass-production basis.

Previously riveted and later spot welded by means of a single spot machine, the entire line of Stran-Steel joists, studs, half-studs, and narrow studs of light-gage copper bearing steel is first formed into angles or channels and then so joined as to provide a nailing space along the entire length of each member. The projection formed by bubbles stamped at regular intervals along one half of the completed section provides this nailing space.

Two identical machines are used, each employing twelve vertically opposed sliding contact guns and six welding transformers (one for each spot weld made). An air-hydraulic booster with a large reservoir and high pressure capacity is actuated by air to supply sufficient hydraulic pressure for the simultaneous operation of the 12 guns.

To accommodate various widths, provision is made for adjustment as to distance between guns on each side. Guns may be moved also for

Opposite end of multiple welder

the proper spacing between spots longitudinally. This, together with the provision made for cutting out the guns on either side (permitting the machine to be used for welding half stud members) makes each machine capable of welding any of the sections.

Since the varying gages of metal require different welding pressure, time, and current, provision for adjustment of each is made.

Assembly of the sections preparatory to welding is done by the welder's helper who places the angles (in the case of joists) in position and clamps them. The clamped assembly, usually measuring some 30 feet in length, is then started through the welding machine. The section is pushed through until the first bubble on each side of the section is in position at the first welding gun station, a weld is made, and the "C" clamps removed.

The three bubbles on each side of the section are then positioned for welding by the three sets of guns. The operator closes the pilot and the 12 guns come together on the work making the six welds (three on each side of the section) simultaneously. This is repeated until the entire section has been welded. The section is then cut to required length.

BURRS

Blast Cleaning Machine Speeds Production

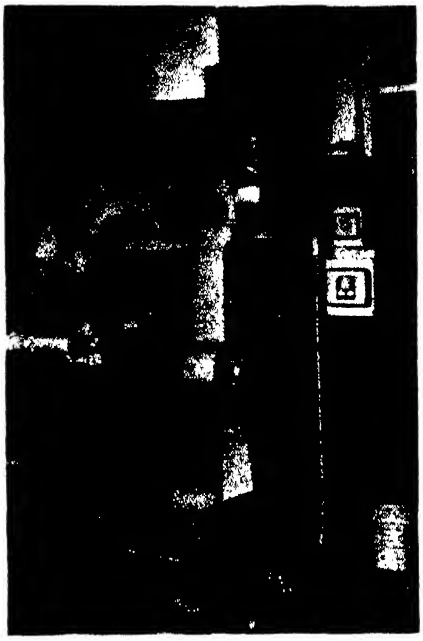
Removing burrs from machined parts can often be a most vexing and expensive problem. Usually it is entirely a manual operation, consisting of hand grinding, filing, or scraping. In one plant producing small parts on automatic screw machines, for example, the problem of removing burrs was of such consequence that the entire production schedule was thrown off balance.

Someone suggested that the burrs might be removed by blasting with a fine metallic grit in the Wheelabrator Tumblast, an airless blast cleaning machine, which they were operating in another department. They tried the idea and were surprised to find that the machine did a fine job after a short blasting, without injuring the machined part itself.

Another manufacturer was confronted with an equally difficult burr removal job. He had booked a large order for small steel shafts from a customer who demanded a perfectly clean finish. Trouble arose when it was found that a long burr remained in the cut after notching one end of the shaft. Grinding the burr promised to be a costly and a long-drawn-out process, because of the quantity of shafts involved. The producer was faced with the loss of his entire profit on the job unless he could remove the burrs faster and at less expense.

After some experimentation with various abrasives it was found that a small Tumblast machine would remove the burrs perfectly. As a result, a machine was installed. Later the manufacturer reported that the savings from this one job alone repaid his investment and that it is now being used on other cleaning operations.

In another instance, burrs were forming on the end of coiled springs



Blasts burrs from castings

during the grinding operation, because the heat generated was sufficient to weld some of the fine steel particles that were ground off. A few minutes blasting in a Tumblast removed the troublesome burrs from these springs and convinced the worried production manager that here was the ideal way to do the job quickly and inexpensively.

These are only a few of the many burr removal jobs being handled by this unusual method. Generally speaking, the process can be successfully used for this purpose whenever blasting the product with a fine grit is not an objection.

In instances where the finished part is later plated, enameled, or given any other finish such as lacquering, metallizing, painting, and so on, this process not only removes the burrs but also provides a perfect bond for the subsequent coating.

DURAMIN

Age-Resisters Prolong Life of Rubber

Described as an important research contribution for conserving supplies of natural rubber, Duramin, a combination of chemical age-resisters discovered in the Akron laboratories of the B. F. Goodrich Company, will find immediate use in automobile tires.

"By carefully selecting and combining the most effective age-resisters, in the development of which the company was the pioneer,"

states John L. Collyer, president of Goodrich, "our research staff has created Duramin, a combination that acts on rubber to keep it tough and alive, much as vitamins act on the human system. So potent is Duramin that it is effective in minute amounts. In tires, the quantity used ranges from ¼ of 1 percent to 2 percent of the amount of rubber in the compound."

When used in sidewalls and treads, Duramin retards wear by imparting greater resistance to abrasion, which is an important factor in tire mileage. According to the B. F. Goodrich president, the vitamin-like material is also used in the important portion of the tire between carcass and tread. Here, he pointed out, it produces a cooler-running stock by both reducing the amount of heat generated and better resisting it.

MONEL SPEEDS SOAP

Razor-Steel Doctor Blades Replaced

In a large soap manufacturing plant, it was formerly necessary to halt production for ten minutes during every eight-hour shift while the doctor blades that scrape the soap from the drying rolls were honed. The continuous scraping against the hard metal rolls, together with the corrosive action of wet soap, dulled the English razor-steel blades after such short usage.

Since the capacity of this drier was 3000 pounds an hour, or 50 pounds a minute, this ten-minute loss meant a production loss of 500 pounds every eight hours. And this department was working on a 24-hour shift 2½ days a week. These frequent honings caused a total production loss per operating week of 3750 pounds.

In an attempt to remedy this trouble, it was decided to install doctor blades made of heat-treatable "K" Monel. At the end of 188 hours of continuous operation with these new blades, only two honings had been necessary — an average of 99 hours between hones. The wear and corrosion resistance of "K" Monel had sped up production more than 7000 pounds during each 99 hour period.

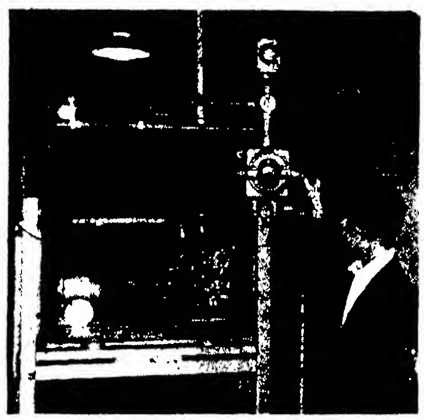
Although no complete records are available after the first 188 hours, it is reported that the new blades are never removed more than once in 60 hours, and usually not so often as that. Thus there is a performance ratio in favor of these blades of more than seven to one over the old type.

GAS ALARM

Explosion-proof, for Sampling Atmospheres

Instant warning is provided by an explosion-proof combustible gas alarm when gas concentrations exceed a predetermined limit. This device, developed by the Mine Safety Appliances Company, may be adapted for automatic control of manufacturing processes or for use in ventilating systems.

The gas alarm, including the sampling pump, is contained in an explosion-proof housing and can be safely installed in gaseous atmospheres, eliminating the need for long sampling lines. The instrument itself is specifically calibrated for the particular gas or vapor which it will test, and is so constructed that the operator can adjust the measuring circuit to operate a warning signal at any predetermined point within a wide range.



Gas tester increases safety

PRESERVING WOOD

Long-Range Test Shows Promise

From the time man first began to use wood as a construction material, one of its most serious drawbacks has been its susceptibility to the destructive action of termites and fungi. Wherever wood construction has had contact with soil and water, myriads of microscopic organisms have attacked even the most costly of wood structures.

Industrial chemists, naturally, sought to develop a means of combating termites and fungi, and a number of years ago The Dow Chemical Company began conducting extensive laboratory research accompanied by widespread field testing programs to develop a positive wood preservative.

According to Dow chemists and technicians, they found pentachlorphenol to be a most effective preservative. In this product they claim to have a material which combines all the advantages of other materials and in addition provides 100-percent protection.

Preliminary experiments were so encouraging that some years ago the company began a testing program to determine the effectiveness of a wide variety of wood-treating compounds. A large number of test experiments were prepared. Sections of wood two by four inches, two feet long, were impregnated with various compounds by means of a full cell process (vacuum impregnation). In this method the sections are placed in a vacuum tank until the air has been withdrawn from the wood. Preservative material dissolved in a suitable solvent is then forced into the cells of the wood under high pressure.

After impregnating in this manner, treated sections were buried in the ground in two testing fields, in locations which were selected because the soil and climatic conditions are particularly suitable for the desired tests.

Yearly checks have been made to determine the effectiveness of the compounds in resisting termites and decay under conditions favorable to both. The results obtained to date show that pentachlorphenol exhibits high efficiency as a wood preservative since at the end of four years untreated sections of samples show only 10 percent of sound wood while all those treated with pentachlorphenol at the rate of 1.58 pounds per cubic foot of wood show 100 percent sound wood.

It is pointed out that pentachlorphenol exhibits outstanding advantages over other materials. It is clean, does not spoil the appearance of the lumber, and is economical to use.

Because of the scope of these experiments and the time necessary before final conclusions may be reached, a complete report on results of tests is not yet available.

INDUSTRIAL TRENDS

PETROLEUM'S FUTURE

DESPITE astronomical figures of petroleum production and consumption, there is still no reason to fear depletion of this natural resource for many years to come. Even though the petroleum industry should do nothing more to develop processing methods than has been done in the past, there is sufficient "black gold" in our developed and proved underground reserves to supply needs for at least 15 years to come. Add to this the undiscovered reserves, which geologists are constantly searching for (and discovering), and the time of depletion is placed further into the future. Add again the fact that science has shown how to obtain gasoline from shale, coal, and other natural deposits, and a variable figure is obtained for the depletion point that may be conservatively placed at some 2000 years hence.

But the petroleum industry *is* doing things about oil, doing many things that not only increase the efficiency with which petroleum products are obtained from the natural crude but, at the same time, open new fields for these products. Indicative of increased efficiency of processing is the new fluid catalytic process of continuous gasoline production recently announced by Standard Oil Company of New Jersey. Claims for this process are economy of plant equipment, more gasoline from a given amount of crude, and higher octane rating for the product.

The trend toward higher octane rating in gasolines holds significance for the entire automotive industry and for every individual motor-car, truck, and bus user. For many years the gasoline division of the petroleum industry progressed side by side with the automotive designers. Better gasolines and better motors were developed simultaneously and the question of which came first would be almost as difficult to settle as the one regarding the hen and the egg. Now, however, it is quite evident that the petroleum industry has forged ahead of developments made by its best customer and has produced gasoline which is so high in quality that existing engines cannot use it to best efficiency.

That the engine designers will rapidly take advantage of this better fuel is a foregone conclusion. With 100-octane gasoline available, and 125-octane fuel a proved possibility, the near future will see automobile engines that will far outstrip present prime movers in such matters as economy, power output for a given motor size, flexibility.

Although the automotive trade is the best customer of the petroleum industry, consuming some 60 percent of its total production in the form of gasoline, lubricating oils, greases, and Diesel fuels, other factors are at work shaping the future trend of those organizations which produce crude. Several rubber substitutes are manufactured wholly or in part from petroleum products, "butyl rubber" being the one that looms most importantly in the field at the present moment. Then there are a score or more of other industries that make extensive use of petroleum. Their products range from plastics to cosmetics, from alcohol to paints, from dyes to medicines. Even explosives can be based on crude oil; it is reported that at least one plant is thus producing toluol, important ingredient of T.N.T., while another is under construction.

From this brief statement of fact regarding the petroleum industry it is not difficult to see that the trend is toward a dual goal: increasing efficiency in production of present products, and diversification of the uses of crude oil and its derivatives.

AFTER THE BOOM, WHAT?

ALREADY the machine-tool industry, heart of national-defense production, is rapidly opening the bottle-neck which has been so widely publicised as to have rendered the very phrase itself a cliché. Millions are being poured into plants and equipment for producing tools, and it is estimated that for at least another two years this industry can look forward to a period of continuing activity.

But then what?

When production plants are tooled-up and in full swing, will the props be knocked out from under an over-expanded machine-tool industry with the tragic result of a slump that descends far faster than the rate of climb to the peak? Will it be found that, in order to provide the tools for emergency production, an industry has been built up that cannot continue on an economically sound basis?

These are questions that must not be lost sight of when considering the present upward trend. Of course, there will always be the necessity of a machine-tool industry geared to normal production. The expected growth of civil aviation, the routine changes in motor-car design, the needs of military aviation even after the crisis has passed, all the normal requirements of industrial production in its many-faceted forms will contribute to a certain stability for machine tools. Then, too, during manufacture for defense, as well as in peace-time production, there is always the need for tool replacements and repairs.

Nevertheless, there will eventually be a downward turn; its severity will largely be governed by the care which is exercised in present planning. The machine-tool industry is undoubtedly the one which will be the first to feel the morning that always comes after the night before.

IF TIN SUPPLIES ARE STOPPED

IF IMPORTS of tin were suddenly stopped, our national reserves of the metal would rapidly disappear. Without going into the international intricacies of the problem, however, it is safe to say that tin consumption in the United States could be radically reduced without working too great a hardship. Lacquer can replace tin in many types of cans; cadmium can be used in place of tin in solder with some advantages, but with the disadvantage of increased cost; lead is a tin substitute that can be pressed into many services; graphite and plastic bearings offer possibilities in replacing tin-using babbit; glass, plastic-treated papers, water-proofed cardboard, and similar materials may be used to fabricate containers of many types that now make demands on tin plate. All of these are proved possibilities that need only the impetus of an emergency to translate them from positions of minor importance to major roles in our national economy.

— *The Editors*

A Strange Picture

Photometers and Spectroscopes Afford the Interpretation of an Odd Double Star

HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

LONG ago, in 1784, Goodricke observed that the third magnitude star Beta Lyrae loses more than half of its light at intervals of a little less than 13 days. As Figure 1 shows, there are deep minima, which last more than a day, alternating with much shallower ones, half-way between. The obvious explanation is that two stars of unequal brightness alternately eclipse one another. The two stars, being very close together, are distorted into egg-shaped figures by their mutual attraction and look brighter halfway between eclipses, when we see them broadside-on, than at any other time. The effects are illustrated by the dotted line in Figure 1, whose minima show how much light we would get from the stars in the end-on position if they did not eclipse one another. Evidently the real difference in brightness of the two stars is much greater than we would suppose if we had not made this correction.

At the primary eclipse, where star *A* is behind star *B*, 36 percent of the whole light is lost; and at the secondary, 12 percent. At the first, *B* hides part of *A*. At the second, *A* hides the same area of the disk of *B*. Hence *A* must be three times as bright per square mile as *B*. It must also have not less than 36 percent nor more than 88 percent of the combined light.

To fix its value, within these wide limits, we need more information. Precise observations of the shape of the eclipse curve should give this, but such measures show that the variations during successive cycles are not exactly the same. Besides the eclipses, there must be something else at work to change by a few percent the amount of light which gets to us. Effects of this sort are probably also responsible for the unsymmetrical shape of the curve at the bottom of the deeper eclipse. Spectroscopic observations show that there is a bright star, with a spectrum closely resembling that of Rigel, which moves in a circular orbit and gets to the far side of it (when an eclipse would occur) just at the time of principal minimum. This is clearly our Star *A*. If Star *B* were comparable in brightness we would expect to find a second set of spectral lines, shifted to the red when those of *A* went to the violet. No such lines have been observed: so we can be sure that *B* is much fainter than *A*. It is probable that *B* is also smaller than *A;* but we can set a limit to this. If we assume that *B* is completely hidden behind *A* at the secondary minimum, then *B* gives 12 percent and *A* 88 percent of the whole light. At the primary minimum, *B* cuts off 36 percent of the whole light, or 41 percent of the light of *A*. Hence its diameter is 64 percent of *A*'s—exactly if the star disks appear of uniform brightness, and approximately in any case.

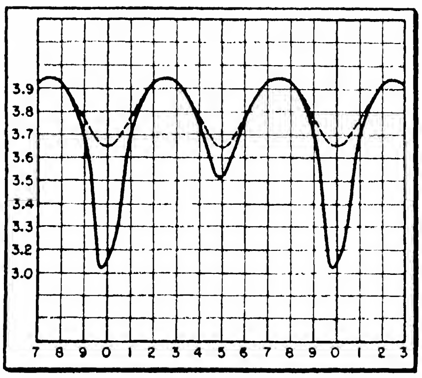


Figure 1: **Light-curve of Beta Lyrae, from observation by A. Danjon, Strasbourg, 1923-1926**

We still want to know the relative masses of the two stars. Dr. Kopal—to whom the calculations just described are due—has found this in a most ingenious way. The observed variation of light outside eclipse must almost all come from the bright star *A*. Hence, comparing the end-on and side-on brightness, we can find its shape, allowing for the fact that on an egg-shaped star, the parts farther from the center are faintest. Kopal finds that the equatorial radius of the bright star, pointing toward the companion, is 15 percent greater than the one at right angles to it. The mass of *B* required to produce this distortion by its attraction comes out 74 percent of *A*'s mass.

Taking the Sun as standard, he finds

	Mass	Diameter			Density
		Longest	Intermed.	Polar	
Star *A*	65	56	48	41	1/1700
Star *B*	48	35	32	31	1/720

With a surface temperature of 11,300°, corresponding to the spectral type, the (visual) brightness of *A* comes out 14,000 times that of the Sun. The "invisible" component *B* would then be 2000 times as bright as the Sun. Were it not drowned out by the glare of its enormous neighbor, it would be most emphatically visible.

THE spectrum is extraordinarily complex. It shows the lines of Star *A* and does not show Star *B*—which is easy to understand. But there is also another set of numerous dark lines, corresponding pretty closely to a spectrum of Class *B5* (that is, to a higher temperature than Star *A*) which hardly shift at all in the orbital period but are displaced, all the time, by an amount corresponding to a recession from the center of the orbit of *AB* at the rate of about 50 kilometers a second. These lines are very strong just after the primary eclipse, and faint shortly before the secondary. There are also strong, wide, bright lines, such as would be produced in an envelope of gas of very low density, surrounding the binary pair and rotating with a maximum velocity of about 300 kilometers a second. Finally, shortly before the primary eclipse, strong dark lines appear on the red side of the principal lines of Star *A*, shifted by an amount corresponding to a motion toward the star at 200 kilometers a second. These disappear abruptly a few hours before the middle of eclipse; and, just after this, a new set of companion lines suddenly appear, shifted to the violet by an amount corresponding to recession from the central star at 300 kilometers a second.

There are more details—but those are sufficiently strange.

A practically complete explanation of these extraordinary phenomena was given recently by Struve. Its general outlines can be understood from Figure 2. This shows Star *A*, with *B* going around it in its orbit in the direction of the arrow. From the surface of *A* a great stream of gas flows outward past *B*, as suggested by the arrows, at speeds up to 300 kilometers a second. Part of this swings around *B* to the other side and probably finally falls into it; the rest spreads out in space and forms some sort of ring, or shell, *C*, enclosing both stars, as indicated very roughly by the dashed lines. The gases of *C* absorb the light from *A* and produce the "stationary" B5 spectrum. They have to get rid of the light which they absorb and do so by shining on their own account—thus producing the bright lines. The ring as a whole is rotating, so that the lines emitted from one side are shifted toward the red and from the other toward the violet, producing wide blends. The ring is continually expanding and dissipating into space, as well as rotating; hence the part of it in front of *A* is receding from the center of the system, producing the shift of the absorption lines.

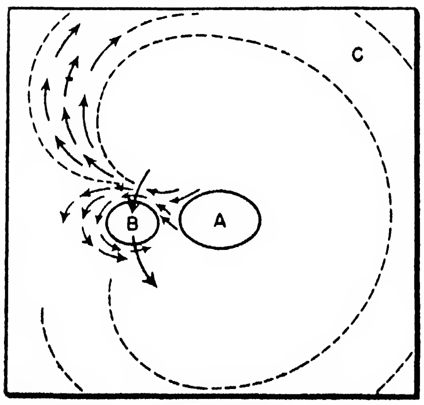


***Figure 2:* Interpretation of the motion of gases near Beta Lyrae**

Before eclipse, the inward-swinging stream of gas on the front side of *B* comes into line between us and *A*, and produces the satellite lines shifted to the red. At the middle of eclipse these get out of the way while the outflowing stream behind *B* produces the "violet satellites." At this time, and for a day or so later, there is more outflowing gas than usual in front of *A;* hence the B5 spectrum is strengthened.

This strange picture is worked out by Dr. Struve in convincing fashion, taking account of a multitude of fine details which there is no room to speak of here, and there can be no doubt that it accounts for the spectroscopic facts.

But is it physically reasonable? Can there be, near these stars, a "wind that blows between the worlds", not cold, but incandescent, and blowing almost a million miles an hour? What drives it, and where does it go?

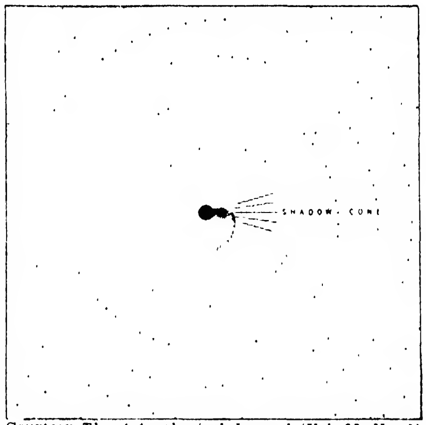
An answer has been given by Kuiper: it depends on surprisingly simple physical and dynamical principles — though the mathematical details are intricate. The main reason for the disturbance is that Stars *A* and *B* are of unequal density. Kopal's calculations indicate that this is a fact; and Bethe's work shows that it has to be that way—if, indeed, the two stars are at least roughly similar in composition.

A star of larger mass will send out more heat, all told, and more per ton; but, since the rate of heat-production increases enormously with the internal temperature, this will not be much higher than for a smaller star, and this means that the more massive star will be of lower density.

SUPPOSE that in some way a pair of stars of unequal masses and diameters were brought so close that they almost touched one another, and set in motion in circular orbits; and consider a small particle in the gap between the stars. It will be attracted by the two, in opposite directions. If the forces on it are properly balanced, it will remain suspended in space—otherwise it will tend to fall into one star or the other. (The centrifugal force, due to motion about the center of gravity of the system, which lies inside the larger star, has, of course, to be taken into account.)

For a pair of stars nearly equal in mass, but decidedly different in density, such as Kopal's calculations indicate in Beta Lyrae, the attraction of the smaller but denser body will preponderate, so that material in the gap—or even at the end of the Star *A* which faces it—will be attracted toward *B* and stream across the gap into it, producing the current shown in Figure 2. The gases of the current will be attracted straight toward *B;* but, before they get there, *B* will have moved forward in its orbit, so that the stream will flow on its following side.

If the material is not going too fast, the attraction of *B* will pull it in close to it, producing the return current on its preceding side. But if its speed is great enough, it may escape, and spread out into space to form the ring *C*. Kuiper, after an extensive mathematical discussion of the possible motions, concludes with the diagram reproduced here as Figure 3. This represents the position of the ejected matter at a given moment. To follow its motions we must suppose the whole diagram to revolve about its center so that an expanding spiral of gas surrounds the revolving stars.



Courtesy *The Astrophysical Journal* (Vol. 93, No. 1)

***Figure 3:* The system of Beta Lyrae in rotation. From Kuiper**

The ejected matter, as shown in Figure 3, would form a substantially flat disk, lying in the orbit plane. This must be almost exactly edgewise toward us (since the ejected gases get in front of Star *A*). These must be somewhat opaque to light of all colors—and differences in the amount of material ejected during different revolutions will explain the irregular variations in brightness.

This is perhaps the most remarkable picture of a celestial object that has ever been seriously presented. But it depends in detail upon careful dynamical calculations as regards the motions, and on thorough physical studies as regards the spectra. It brings order out of apparent chaos and combines practically all of the perplexing facts of observation into a consistent and intelligible whole. Its authors are heartily to be congratulated upon the solution of a particularly troublesome problem.

Most of the puzzles are thus cleared up, but one big one remains. How did these stars get that way? This we cannot presume to answer.

Quality in Warplanes

How the British, Out-Numbered in Aircraft, Forced a Change in German Tactics

• CONFLICTING opinions arise everywhere regarding the relative efficiency of the British and German air forces. Hence it was refreshing and informative to read, in a recent number of *The Engineer* (London), a calm analysis of the whole situation. With the permission of the publishers of that magazine, we present herewith a slightly condensed reprint of that analysis. It should serve as a basis for evaluating much of the war news printed in the daily press of the United States.—*The Editor.* •

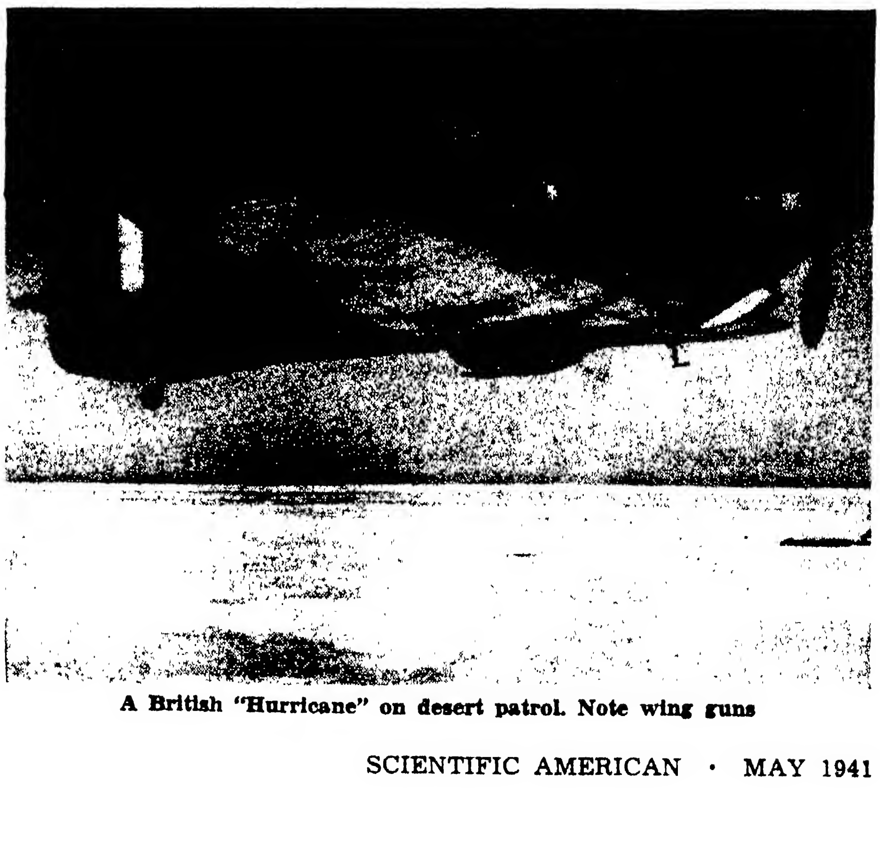
AFTER the first four months of war, it became possible to assert with considerable confidence that if we fell short of the enemy in the number of first-line aircraft at our disposal, British airplane types had, machine for machine, demonstrated their superiority over those of the Germans. Twelve months' additional experience has more than confirmed that early conclusion. We still lag behind the enemy in numerical strength, but the quality of our aircraft—and of our pilots—has been put to repeated and searching tests and in no way has it been found wanting. Again and again British squadrons have routed the enemy at great odds in numbers. Repeatedly our aircraft have returned from aerial combats and from raids damaged to an amazing degree, but still capable of flying and landing at their bases. Much, very much, must be attributed to the superlative courage and skill of our airmen, but it is self-evident that all the heroism in the world could not have achieved what they have done without aircraft of outstanding design and construction.

In September, 1939, Britain was fortunate in having several types of aircraft, possessing notably high performance characteristics and a number of exceptional features, which had fairly recently reached the stage of quantity production. Chief among these aircraft were the Vickers-Supermarine "Spitfire" and the Hawker "Hurricane" eight-gun single-seater fighters, the Vickers "Wellington" long-range bomber, and the Bristol "Blenheim," a bomber-fighter. Chance had played its part in providing us with these designs just when they were needed. The "Spitfire"—and, to a slightly less extent, perhaps, the "Hurricane"—were the direct outcome of the work done in previous years in developing the series of seaplanes with which this country finally won outright the Schneider Trophy. It will be recalled that the contest for this trophy, in its last phase, was frowned upon by the Government of the day and that our success in winning it and all the lessons learned from the efforts made to secure victory would not have been ours but for the generosity of the late Lady Houston.

Private enterprise and encouragement also played a part in the evolution of the prototype of the "Blenheim." As for the "Wellington," with its unique "geodetic" system of construction, it can be truthfully asserted that its existence in numbers at the outbreak of the war is to be ascribed to the courage with which Vickers adopted Mr. Wallis's revolutionary ideas and the skill with which they quickly adapted their works for quantity production.

Nevertheless, although chance played a fortunate part in the position with respect to aeronautical equipment in which we found ourselves in September, 1939, it would be foolish and ungrateful to ignore the deliberate part played by the Air Ministry. The approaching storm was long heralded. The new types of aircraft were not as yet fully developed and were not ready for mass production, either in the works of their designers or in the "shadow factories," which were being organized. It would have been an easy solution to standardize the existing less efficient designs of aircraft and to prepare the way for mass-production on the outbreak of war.

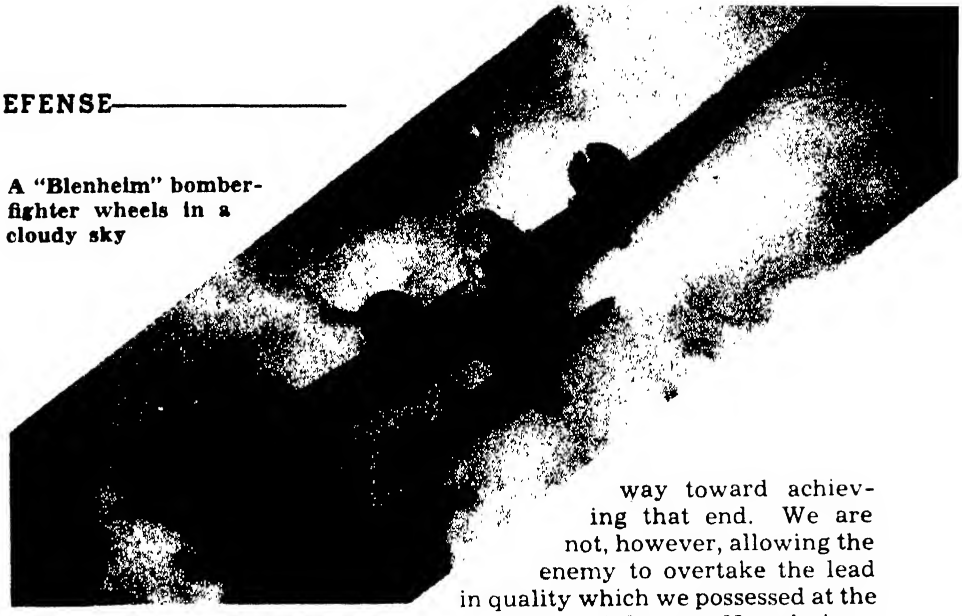
SOME people have criticized the Ministry for choosing the advanced qualities of the new designs in preference to the increased numbers which would have been forthcoming had it adhered to the established types. Where, one may wonder, would we now be if the Ministry had acted otherwise than it did? We can obtain some inkling of the answer to that question by noting the experience of the enemy. The Germans elected to obtain numerical strength rather than the strength which comes from qual-



A British "Hurricane" on desert patrol. Note wing guns

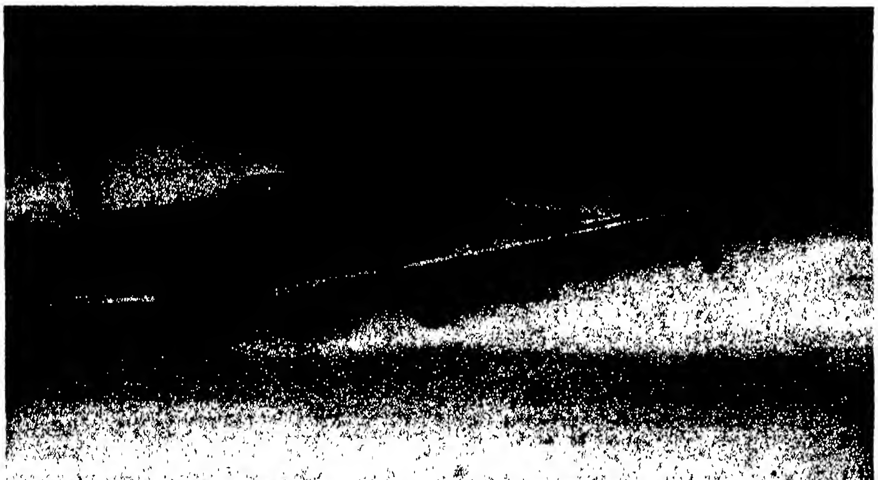
ity. They standardized their production for war at least two years before we did. Those two years were marked by vital developments in aircraft production. They witnessed the advent not only of the new British designs to which we have referred, but of the power-operated gun turret and other devices which have fully proved their worth in battle during the past 12 months. The Germans missed most of these developments and are still struggling to catch up with them.

A specific illustration of the above remarks can be given. The most notable, or notorious, type of German "Stuka," or dive bomber, is the Junkers 87 monoplane. It achieved considerable success against the Polish and French forces, but in both cases these forces lacked anti-aircraft defenses and training against dive-bombing attack. The moral effect of these "Stukas" was very great, but their success was quite disproportionate to their intrinsic qualities. Actually, the Ju. 87 design is about eight years old. Not until after the capitulation of France did it find itself pitted against modern air and ground defenses on an adequate scale. When, during August and September, the Germans employed Ju. 87's against our shores and shipping, more than half those engaged were destroyed, chiefly by our "Spitfires" and "Hurricanes." While it is not permissible to say what improvements we have made in the dive-bombers with which we started the war—such as the Blackburn "Skua" and the Hawker "Henley"—it can be stated that a recent American design, the Douglas DB 7, has a top speed of about 330 miles per hour. That speed is not far short of that possessed by the early patterns of "Spitfire" and "Hurricane." In contrast to it the Junker 87 has a top speed of only about 240 miles per hour.



A "Blenheim" bomber-fighter wheels in a cloudy sky

From these facts we may infer something of the penalty which the enemy has had to pay for his too hasty decision to standardize his aircraft production. That decision might have been a profitable one to him had the war started a year earlier than it did. As it was, the Munich conference gave us a year's breathing time and enabled us to win the race for quality as against numbers. Today we are bent on making up the disparity in numbers, and, with the aid of the United States and Canada, we are in a fair way toward achieving that end. We are not, however, allowing the enemy to overtake the lead in quality which we possessed at the beginning of the war. New designs, such as the Bristol "Beaufort" bomber, the Boulton-Paul "Defiant" fighter-bombers, and the Fairey "Fulmar"—the Fleet Air Arms' counterpart to the "Spitfire"—have already been brought into service, and others of which no mention may be made are on the way.



Ready to lay its eggs; a Fairey "Battle" bomber

Different opinions have been expressed concerning the quality of the workmanship and materials revealed by the German aircraft which have fallen into our hands. Some assert that the Messerschmitt 109 fighter is an inferior product, both in general design and in construction. It has no bulletproof windscreen and no armoring for the pilot. The fuel tank is badly positioned relatively to the center of gravity and is very vulnerable. Its armament and equipment, it is said, are so inferior that, given two pilots of equal skill, the Messerschmitt must be shot down every time by a "Spitfire" or "Hurricane." On the other hand, equally competent investigators have found no sign of *ersatz* material in any German aircraft which they have examined. They praise particularly the design and quality of the enemy's self-sealing petrol tank and his engines. It has been asserted, too, by some, that many German aircraft are poorly equipped with flying and navigational instruments, while others have found no deficiency whatsoever in these respects. It seems probable that these contrasting opinions may both be well founded and that there is a very considerable variation in the quality and construction of German aircraft. Doubtlessly, opinions based on the examination of aircraft constructed before the war or during its early and less intense months are likely to be different from those derived from the in-

spection of more recently constructed machines.

If there is thus some difference of view concerning the quality of German aircraft there is none concerning that of British machines. As we have already said, numerous reports have been received of British aircraft returning safely to their bases in an amazingly damaged condition. One typical instance may be quoted. A "Wellington" bomber during a raid collided with a balloon cable which cut through the leading edge of the starboard wing, tore off the wireless aerial, damaged one of the airscrews, cut completely through the starboard aileron and severed it, ripped off the bomb doors, and did other smaller damage. Nevertheless, the machine succeeded in reaching home in safety. It is needless to say that in the last war any such mishap to an airplane would have meant its instant destruction.

Several instances, too, have occurred of British aircraft catching fire while under bombardment. In the last war, with the machines largely of wooden construction, fire almost invariably spelled immediate disaster. Today it has been proved that, with prompt and courageous handling, fires on aircraft can be extinguished and that the machine after its ordeal can still be safely brought home.

Large-scale air attacks on this country were begun by the Germans on August 8th. At first they were principally confined to daylight hours and were primarily directed against our shipping in the English Channel and our southern coastal towns and ports. It took some time to convince the enemy that he was at last fighting a country which was prepared and able to hit back at him. At the end of 12 weeks, however, our fighters, anti-aircraft gunners, balloon barrage, and other elements of defence, had accounted with certainty for 2433 enemy bombers and fighters, omitting all those which were "probably destroyed" or "damaged." In that period over 6000 German airmen were killed or taken prisoner for a loss of 353 pilots on our side. Gradually the enemy started to change his tactics. He began by providing stronger fighter escorts for his bombing squadrons and continued to develop this plan until it reached an almost fantastic scale with hordes of fighters accompanying one or two bombers. His losses diminished somewhat, but equally, too, did the damage he could do.

By the beginning of September it was as clear to the Germans as it was to us that daylight air attacks were very costly, far too costly to be continued on the scale which they had previously followed. For the time being, at least, we had mastered them with our fighters and our guns. As was to be expected in these circumstances, the enemy resorted to night attacks. In these attacks he has certainly found a field congenial to his brutal soul. He need no longer fear our "Spitfires" and "Hurricanes;" he can fly, if he chooses, as he generally does, at such a height as to be beyond the effective range of our searchlights—and beyond the range at which any pretense of precision bomb aiming is a farce; he can come over in nearly all kinds of weather, for his code of warfare does not compel him to emerge from the clouds to seek his target, and, with the location of aircraft at night in its present state of development, he has much less to fear from our anti-aircraft guns than he has been taught to feel from his experience by day.

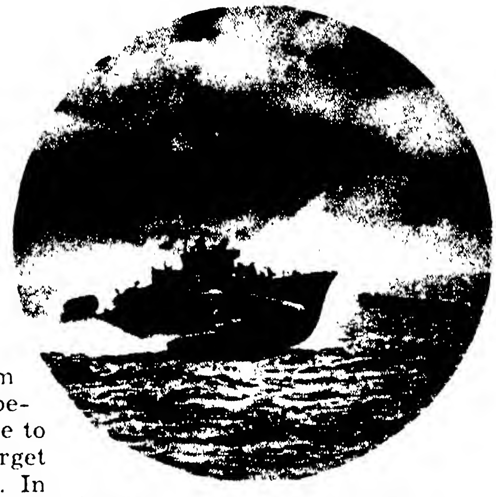
Vickers "Wellington" long-range bombers

It may be noted that of the 2433 enemy aircraft destroyed during the 12 weeks beginning on August 8th, to which we have referred above, 341 were shot down by our anti-aircraft guns, an average of a little more than four each day. Our gunners have certainly given a good account of themselves by day. They have improved their practice to such an extent that on at least one occasion they have secured a direct hit on an aircraft flying at a height of about five miles. Nevertheless, it is no disparagement of them to say that their performance after night has fallen, judged by the number of machines which they shoot down, and is far from equal to that which they have achieved by day. The gun barrage 'round London and other centers has now reached a great magnitude. It is not possible to say how many raiders have turned back before its intensity, but it can be asserted that night after night it has failed to prevent a number of machines from reaching their target area. It is certainly not the fault of our devoted gunners that their strenuous efforts by night meet with relatively little success. The fault seems to lie in the fundamental crudity of the system whereby we seek to destroy or damage an airplane in rapid flight by flinging lumps of steel at it more or less with our eyes blindfolded.

Meanwhile, our bombers have been taking their toll on Germany, and will doubtlessly continue to do so with ever-increasing effort as the strength of our Air Force rises. Unlike the enemy, we have from the first concentrated on military targets and on works of all kinds which are contributing to his war potential. Our operations conducted from this country have extended from as far east as Danzig to as far south as Naples, and from all accounts have met with much success. The enemy, it would seem, is still as far off as we are from finding an adequate means of preventing successful attack by night-raiding bombers, in fair weather and foul.

Speed and Sting—the M. T. B.'s

Motor Torpedo Boats Attain Speed of 60 Knots, Carry Four Torpedoes, Machine Guns



British motor torpedo boats have proved their worth in war

A FLEET of tiny speedboats which dart in like rapiers, stab deep into an enemy's vitals, and withdraw speedily may soon become one of the bulwarks of national defense, if the motor torpedo boats now being tested by Uncle Sam's Navy measure up to expectations.

The little sea hornets are able to reach a speed of 60 knots. They can maintain this rapid clip and carry out their mission in waves running from 12 to 15 feet high.

The drive behind such terrific speed is furnished by three 1200-horsepower supercharged Packard engines of 12 cylinders each, which are housed in the engine room aft. To obtain maximum efficiency of operation, 100-octane gasoline is used, and enough is carried to give a boat a cruising radius of 3000 miles.

The method of attack used by motor torpedo boats is to dash in, deliver a telling blow and dash out again. The boat's silhouette is so low against the horizon that it is almost invisible to the commander of an enemy ship. The enemy commander doesn't hear the onrushing mosquito boat because its powerful engines are muffled. By the time he sees it and tries to aim his guns, the little fellow has begun to zigzag sharply from side to side so as to make of itself a target that is almost impossible to hit. In close, the motor boat cuts loose its torpedoes, whirls "on a ten cent piece," and is gone.

One of these torpedoes packs sufficient wallop to send an aircraft carrier to the bottom, and a squadron of motor boats, armed with four torpedoes each, is potent enough to sink the largest battleship, experts believe. Each boat carries half the hitting power in torpedoes of a modern destroyer.

Simplicity in launching its torpedoes is another advantage of the motor torpedo boat. Its helmsman puts it on a collision course with its intended victim and holds that course at torpedo speed. The torpedoes are discharged over the side at an angle to the boat's course and return automatically, at a safe distance, to a course parallel to that of the boat.

In addition to four torpedoes of the latest type, four machine guns on twin mounts and a smoke laying apparatus comprise each vessel's armament.

American motor torpedo boat, showing torpedoes, machine-gun turrets

The new motor torpedo boats are undergoing rigid service tests to develop and determine their capabilities and limitations under all conditions encountered at sea. They have already proved that their combination of high speed and maneuverability enables them to outmaneuver all surface ships, even in waves running 15 feet high. Later tests will match them against destroyers in war games, to determine whether or not the destroyers can run them down. Similar tests conducted by the Germans are reported to have shown the motor torpedo boat a more effective sea weapon than the destroyer.

A boat crew consists of eight men and an officer. The men must be young—under 35—and tough, and they are carefully selected for their experience and ability in handling torpedoes, torpedo controls, machine guns, and gasoline engines.

Boats which are subjected at high speeds to such a pounding as the mosquito boats require lightness and strength in the construction. Hull planking, which is double, is of African mahogany with a total thickness of almost an inch. Laying the planking diagonally imparts great strength, and doped fabric between inner and outer skins assures water tightness. So buoyant is the structure that it would float even with all watertight compartments flooded.

Its beam of 22 feet gives a motor torpedo boat great stability in rough water and its draught of only five feet enables it to venture into waters far too shallow for larger fighting craft.—From *Ethyl News*.

Atom Smashing: Two Methods

Why the Weaker Electrostatic Atom Smasher Thrives Despite the Powerful Cyclotron

C. W. SHEPPARD
Professor of Physics, South Dakota School of Mines

For many years prior to the 1930's, physicists had studied the outside of the atom. The rules governing the behavior of the minute electrons which revolve about the central nucleus at tremendous speeds were just commencing to become clear. Scientists were then making every effort to get in beyond the exterior and probe into the secrets of the nucleus itself. By the opening of the decade, they felt that they were beginning to "hit the jackpot."

One method of research which suggested itself was to shoot at the nucleus and see what could be knocked out of it. Already, some success had been achieved in shooting into atomic nuclei the minute, charged projectiles emitted by radioactive materials. These particles, emitted in radioactive "explosions," were known to be the nuclei of helium atoms and went with such speed that scientists said they had energies of several millions of volts.

This strange way of speaking can best be explained if we know what was going on in their minds during that time. Suppose, they said, that one could bombard the nuclei of atoms with charged particles. To obtain these, the experimenter would take simple atoms such as hydrogen, or helium, and knock off the outer electrons by throwing them violently around in an electrical discharge or in some other way. The gadget in which this "knocking off" process occurred would be connected to a large, highly evacuated glass or porcelain "accelerating tube." The particles could be led into this tube and, by the application of high voltage, could be accelerated or shot against a target covered with the atoms of the element to be investigated.

But how does this acceleration occur? Let us imagine for a moment a battery connected to an electric circuit. To speak of the "voltage" of the battery is merely another way of referring to its ability to push electricity or electrical charges through the circuit. If we could have a battery of a million volts, its ability to push electricity would be very high. Now suppose, in place of an ordinary circuit, we have a large, evacuated, accelerating tube full of charged particles which we wish to use as projectiles. Since the particles have lost one or more negatively charged electrons in the knocking off process, they are now positively charged. The battery will still be able to push, and this will cause electricity to pile up so that one end of the tube will be highly charged positively and the other end highly charged negatively. Since like charges repel and unlike attract, the atomic projectiles inside will be repelled from the top end and attracted to the bottom end, and will shoot down the tube at very high speeds. The more positive charge the particles have gained by losing their negative electrons, and the higher the voltage on the accelerating tube, the faster they will be shot. These two things will then determine their energy of bombardment. It is thus most convenient for the experimenter to measure the energy of bombardment of his particles in terms of voltage and electronic charges, or electron volts. For simplicity, we shall call them just plain volts.

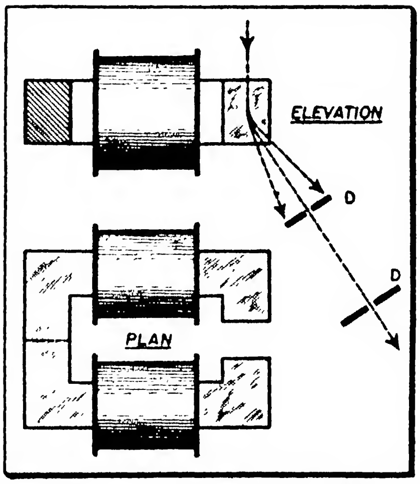


Figure 1: **Principle of the magnetic separator. The bombarding beam is shot between the poles of a powerful electromagnet, which deflects the particles. The lighter ones are more strongly bent than the heavier ones. The magnet is set so those particles which weigh just the amount desired for use in bombardment are deflected just enough to pass through holes in the two diaphragms *D,D,* while all the unwanted particles are caught and do not get through**

When physicists sat down to figure out how much voltage they would need to do all of this, it looked pretty hopeless. Nuclei—that is, the targets—carry a positive electrical charge, and the only particles heavy enough to do them any damage are other nuclei. Since these also carry a positive charge, a strongly repulsive force is set up. To shoot a projectile into a nucleus against this force takes such fast particles that several millions of volts are required for their acceleration. This explains why only the particles from radioactive sources had been successful previously.

In spite of the dark outlook, by the turn of the decade, physicists had begun to lick the high voltage and high velocity problem. The future also appeared brighter for another reason. Theoretical physicists were making abstruse calculations by means of the new and mysterious quantum mechanics, and their theories showed that, if one shot a particle at a nucleus, it could "leak" in despite the repulsion tending to prevent it. Only half believing such a weird idea, two English physicists, J. D. Cockcroft and E. T. S. Walton, tried bombarding the metal, lithium, with hydrogen nuclei, or protons, and found that their experiment worked and that they had succeeded in disintegrating lithium artificially. When they announced their success, many other laboratories throughout the world set about with renewed vigor to build high-voltage equipment. A great deal of ingenious, elaborate, and frequent-

ly fantastic apparatus was tried and either adopted or rejected.

Such apparatus, when adopted, was frequently very crude but was used for lack of anything better. For example, one laboratory used "raw" alternating current from a set of 1,000,000-volt transformers built for electrical testing purposes. Such a voltage supply varied from 0 to 1,000,000 volts many times each second, making impossible any knowledge of the energy of bombardment. On the reverse half of the cycle, electrons were accelerated, making large quantities of X-rays, which seriously interfered with the experiments.

Other laboratories were using equally crude methods. Little success was had in focusing the bombarding particles into a fine beam or getting rid of the many foreign particles present in their "ammunition." Frequently, the apparatus would not run steadily but would fluctuate, making correct experiments difficult. Also, the results of these experiments usually gave only tantalizing glimpses into the secrets of the nucleus. Physicists found themselves longing for apparatus with steady bombarding voltage which could be

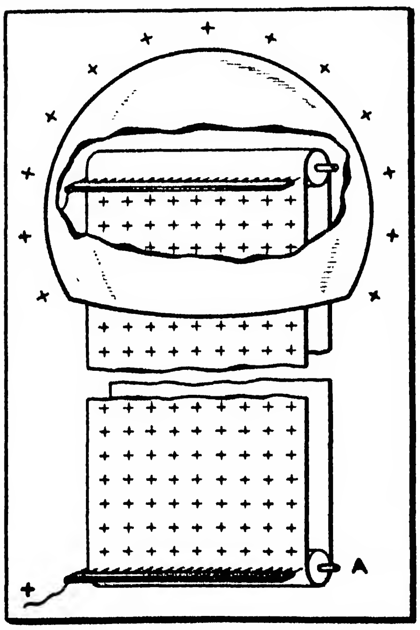


Figure 2: **The working principle of the Van de Graaff generator**

carefully measured and which could be varied at the turn of a rheostat. They desired a small, fine beam of bombarding particles which they could shoot at atoms and measure the angles at which they bounced off. Such a beam was also desirable because it could be put through a magnetic selector, and unwanted particles "strained out" (Figure 1). If the energies of all particles in such a bombarding beam were closely equal, accurately known, and easily controlled, it would afford a rare chance to examine the response of atoms to varying energy of bombardment. Physicists then could have learned more about the critical energy levels which some nuclei possessed, in which they reacted vigorously to certain very sharply defined energies and not at all to energies of a few thousand volts, more or less. At the time, however, these day-dreams seemed more utopian than practical.

DURING all this early furore, R. J. Van de Graaff, a young electrical engineer, was conducting novel experiments with high voltage electricity at the Massachusetts Institute of Technology. Any person who has worked in a mill or factory where large belts are used doubtless has had the experience, on a dry day, of putting forth his finger and drawing sparks from such belts. Van de Graaff proposed to use this principle to generate high voltages but, instead of doing it accidentally, his belts were purposely designed to carry electricity. Since high voltages, but small currents, are required for speeding up particles to bombard atoms, this type of generator promised to be ideal. Preliminary experiments showed that the principle (Figure 2) was a sound one. A large spherical metal conductor was made and mounted on the top of a hollow insulating cylinder. Inside, a belt ran between two rollers, one in the sphere and one on the floor. High-voltage electricity was "sprayed" on the belt by the use of a metal comb charged to a few thousand volts by a direct-current voltage obtained from a transformer and rectifier. It was then taken from the belt at the top and transferred to the sphere by means of another comb and connecting wire. By this means, Van de Graaff was able to produce long, high-voltage sparks. Persons standing near the generator found their hair standing out because of the strong electrical field produced.

Encouraged by his success, Van de Graaff laid plans for a 5,000,000-volt installation, which was soon built in an old dirigible hangar at Round Hill, Massachusetts. Some physicists shook their heads when they saw this impressive piece of machinery. True, it made tremendous high-voltage sparks 40 feet long, but they felt that the problems associated with such an undertaking were still too great. In the first place, it could only make high voltage. No accelerating tube had yet been developed that could withstand such voltage, and the

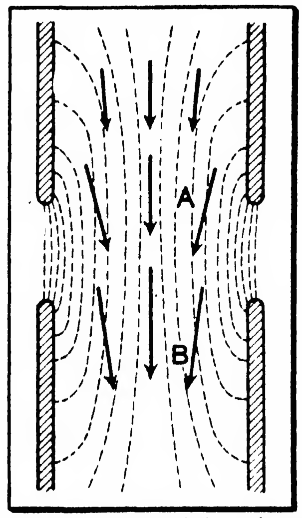


Figure 3: **Principle of the electron lens. Arrows represent speed and direction of particles. At top, particles are traveling slowly. Those off the axis are deflected inward by converging lines of force at *A*. At *B*, lines of force diverge, are deflected outward. This now has less effect as they have been speeded up by action of accelerating voltage. This divergence is not enough to overcome inward velocity acquired at *A*. Result is a converging action on beam**

development of apparatus to convert such energy into a stream of bombarding particles promised to take several years of work.

There was one physicist, however, who came, saw, and was convinced. This was Dr. Merle A. Tuve, of the Carnegie Institution of Washington. Starting out more conservatively, he and his coworkers set to at once and constructed a low-voltage Van de Graaff generator connected to an accelerating tube. It turned out to be so successful that they at once undertook to build a larger installation running at 1,500,000 volts. A year or two of hard work showed that they were on the right track. They used a method by which bombarding particles were accelerated down a long tube through a series of metal cylinders, each of which had a higher voltage than the one below it. The gap between each cylinder and the one below it

formed an electrical "lens" which had a strong converging action on the particles, focusing them into a small beam (Figure 3).

This focusing could be adjusted by varying the voltage from gap to gap. The gap voltages were adjusted by using the corona effect. That is, if a conductor is charged to a high voltage, the air about it becomes charged and these charges leak away, allowing the electricity to leak from the conductor. This leakage is small from very flat surfaces, but it becomes very large when the curvature is great, and it will become very large indeed if there are points on the conductor. Tuve connected his focusing cylinders to rings or hoops surrounding the tube outside (Figure 4) and connected to adjustable corona points. By adjusting the corona points between stages, he was able to create a sort of electrical waterfall down the outside of the tube, cascading from the large conductor at the top to the ground. By moving the spacings of these points, he could adjust the voltages and focusing of the various stages until a fine beam of bombarding particles was produced at the bottom in which the velocity, and thus the bombarding energy, was uniform, steady, and easily controllable.

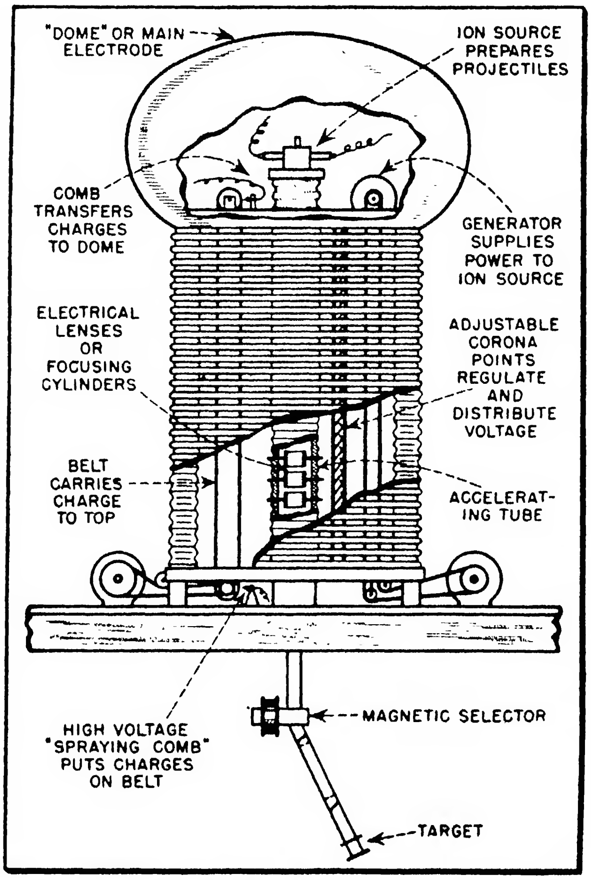


Figure 4: **Tuve's type of Van de Graaff high-voltage generator (see description in text)**

BUT there still was room for improvement. The performance of the generator was subject to atmospheric conditions. On a rainy day, the high humidity prevented successful operation. Then, too, the 1,500,000 volt installation was quite bulky. The only prospect of increasing the voltage lay in cutting down the corona leakage from the large spherical conductor at the top. To do this, it was necessary to cut down the curvature of the conductor by making it larger. This made it necessary to build even larger equipment, increasing the mechanical difficulties.

However, about this time, Dr. R. G. Herb was experimenting in the basement of the physics laboratory at the University of Wisconsin with a strange piece of apparatus which looked like a steam boiler. He was trying to give direct expression to an idea which had long been dormant in the minds of physicists. They had often thought that, instead of making the generator bigger, one might put the entire apparatus into a tank filled full of compressed air at a pressure of, say, 100 pounds per square inch. Under high pressure the corona leakage of air is greatly cut down, and the same voltage increase can be effected with no increase in space.

Herb had set himself an engineering problem of the first magnitude, yet by 1937 his generator was in operation and producing spectacular results. With a tank 20 feet long and 5½ feet in diameter, he was able to generate almost 2,500,000 volts, accelerate particles, and focus them into a small beam which was as steady as a rock and with a voltage which was uniform to a fraction of a percent. With this generator, he and his assistants quickly turned out research which earned the admiration of all the other physicists working in the same field.

AT ONCE Tuve laid plans for an enormous generator of the same type, with which he hoped to generate 5,000,000 volts; and at the Westinghouse Research Laboratories, a similar installation was soon begun. These generators were of truly gargantuan dimensions. The Westinghouse installation, with its pear-shaped housing, for example, is 47 feet high. One can readily imagine the new technical problems which arose in designing and building such massive apparatus. In the construction of Tuve's generator, an additional problem arose. Due to zoning restrictions in the neighborhood, no "laboratories" were permitted. The difficulty was resolved by surrounding the tank with a streamlined structure built of glass bricks and calling it a "nuclear physics observatory."

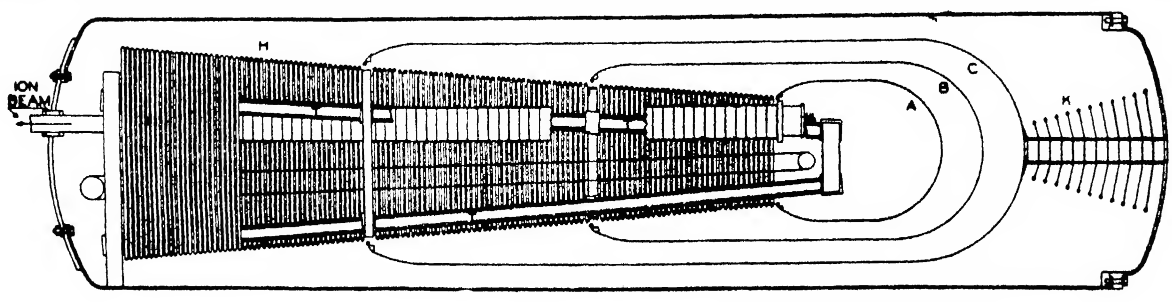


Figure 5: **The most recent, remodeled form of the Herb version of the Van de Graaff generator.** ***A, B*** **and** ***C*** **are aluminum shells.** ***T,T,*** **Textolite tubes.** ***H,*** **aluminum hoops.** ***K,*** **Textolite tube with corona gap system**

Preliminary tests on these large generators showed that there were many "bugs" to be eliminated before they would deliver the expected voltage. However, the Westinghouse generator was able to accelerate particles to 3,750,000 volts, and the men working with it had already done some important research even before attempting to push the voltage higher.

Dr. Herb was still undaunted by all this streamlined competition. Retiring to his basement, he opened up his tank and started remodelling the interior. By the middle of last summer he was able to announce he had succeeded in increasing his voltage to 4,500,000 volts! To do this, he had merely surrounded the single main conductor of the previous generator with two additional, larger, concentric conductors charged to intermediate voltages. (Figure 5.) In such an arrangement, each conductor exerts an electrical "shielding" effect upon the one inside of it, so that discharges and electrical corona are cut down, thus making it possible to reach much higher voltages on the inner conductor.

No doubt, in recent months many people have read about the enormous cyclotrons now being built and have marveled at the tremendous voltage such apparatus can deliver. To them it may appear somewhat peculiar that certain scientists are still building expensive and bulky generators which will produce only 5,000,000 volts. The reason lies in the fundamentally different use to which the Van de Graaff generator can be put. Here one has a steady, uniform beam of particles whose voltage can be raised or lowered from zero to the maximum at the mere turn of a knob. This flexibility is something the cyclotron lacks.

No intelligent physicist today would say that one or the other type of apparatus was the "better," since it is not a question of absolute superiority. There are some types of research in which one does not require any of this gargantuan apparatus at all. For example, the discovery of the neutron was effected with a little radioactive polonium, a plate of beryllium, some paraffin, and a few radio tubes. But there are other research jobs in which no amount of ingenuity or hard work will replace the necessary expensive apparatus. If the job happens to be one that requires very high voltages, a cyclotron is necessary. On the other hand, if it requires a finely focused beam of uniform voltage which can be easily regulated, it is a job for which the Van de Graaff generator is best adapted.

Those jobs which require both high voltage and precision are the ones which still offer a challenge to the physicist. If he is clever enough, he can lick the problem. If not, such research still lies within the unknown realm into which scientists are constantly striving to penetrate.

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PETROLEUM RESEARCH

Increased 539 Percent in Eleven Years

PETROLEUM research has expanded so rapidly that the industry now ranks second in scientific investigation, Dr. W. A. Hamor, associate director of Mellon Institute, reported recently in a survey published by the American Chemical Society.

In the past 11 years the amount of research by the petroleum industry has increased 539 percent, Dr. Hamor said. From seventh among all industries, it has risen to second place.

HOME-IDITY

Heated Houses More Humid Than Generally Believed

VERY little definite information has been available concerning humidity conditions actually prevailing in occupied houses. To obtain trustworthy data, a humidity survey was made by the National Bureau of Standards. Measurements of relative humidities in a number of houses in each of 26 localities in the northern part of the United States were made during the first part of the year 1938. The results of this survey have been published as Building Materials and Structures Report BMS56, obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C.

As was to be expected, the interior relative humidities are low when the outside temperature is low, and they rise when the outside temperature rises. The air in an occupied house has, however, a considerably higher moisture content than the outside air, because of the moisture supplied by various sources within the house. The survey also indicates that many humidifying devices in use produce little effect.

AIR TRIGGER

Odd Sequence of Events Sets Off Many of Our Earthquakes

EARTHQUAKES are shocks or jars caused when parts of the earth's crust slip past one another. The quakes do not cause the slipping, but the slipping is the cause of the quakes. Cause of the slipping is the gradual accumulation of greater and greater forces since, if this goes on long enough, a slip must occur. Many earth scientists suspect, however, that actually in numerous instances some tiny outside force precipitates the slip when the forces of pressing rocks almost balance the strength of the rocks—much as one could think of a plank which was almost but not quite ready to break, suddenly breaking on the addition of a feather or under a puff of breath. "Trigger effects," these are called.

One suspected trigger effect in the case of some earthquakes is the constantly changing weight of the air bearing down on the earth, as the weather changes. Something like this is the basis of a theory advanced by Dr. H. Landsberg, geophysicist at the Pennsylvania State University.

Climatological and meteorological conditions, especially the change of seasons, produce a transport of large masses of air from one hemisphere to the other, across the equator. This causes a change in mass-distribution of the earth itself. That, in turn, results in a slight change in position of the earth's poles of rotation. Such a shift of the poles brings each region of the earth under a different centrifugal force If there are in any part of the earth's crust, or in the material beneath the outer crust, latent energies piled up to the verge of breaking, the small change in centrifugal force may act as a trigger that releases them.

On test, a comparison of the earthquake record with hemispherical changes in atmospheric pressure over the decade 1921-1930 indicates that this kind of force did act as a very important trigger to set off quakes.

Human Hibernation

What Today of the Frozen Sleep Therapy for Cancer? Failure, or Success?

BARCLAY MOON NEWMAN

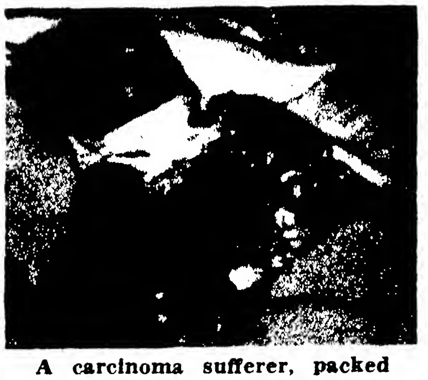
CRYMOTHERAPY, popularly known as "frozen sleep" and "human hibernation," is proving to be an important medical advance. Originated by the logic of Dr. Temple Fay, of the Temple University School of Medicine, Philadelphia, it has been extended with conservatism and utmost caution. Though its medical sponsors make no claims as to therapeutic value, careful use of crymotherapy has already had successes in surprisingly different fields.

In 1932, Dr. Fay had occasion to make standard neurological examinations involving taking of skin temperatures at many body sites. As he went on with this work, nature appeared to give one of her rare hints. In normal human beings, the lowest body temperatures—88 to 90 degrees, Fahrenheit—are constantly found along the skin of the extremities, below the elbows, and below the knees. In the breast region, higher temperature is steadily maintained. A question darted into the neurologist's mind: Can temperature differences explain differences in the incidence of cancer? Breast cancer has a high incidence, whereas cancer rarely spreads below elbows and knees. These phenomena he pondered.

Four years later, Dr. Fay had the opportunity to experiment, and essayed to find at what temperatures cancer cells flourish best, what other temperatures retard tumors. He demonstrated that sustained cold—between 40 and 50 degrees, Fahrenheit—can retard cancerous growth in the body. But there are difficulties, sometimes insuperable. The temperature of the whole body cannot be lowered to such an extent, and local refrigeration, by means of cold water circulating through metal tubes, is applicable only where the tumor is accessible. It has, however, been effective in a few cases. Next, as the pioneer significantly relates:

"After two years of observation on the destructive effects of cold when applied to local cancer, and with the confirmation from tissue culture and embryonal studies that 'critical' temperatures exist below which cell activity ceases, it naturally followed that attempts should be made to reach the deep tumor masses which are not accessible to local refrigeration."

A side discovery provided an essential basis for refrigeration of the whole body: prompt and dramatic relief of pain follows local cooling. Patients in extreme agony and in immediate danger of death from inoperable cancer would surely be benefited, not harmed, through such therapy if it were carefully extended. Relief of pain in itself therefore gave ample justification for Dr. Fay's first effort to combat cancer by refrigerating the entire body.



A carcinoma sufferer, packed in cracked ice—painless sleep

Was it possible and safe to reduce the temperature of the deep organs of the body significantly—say below 90 degrees? In December, 1938, a female patient had undergone local refrigeration and had shown no untoward reaction. Her tumor was extending its growth. Rapidly sinking, she volunteered for general crymotherapy—the first in history. She was anesthetized. In a cool room, she was surrounded by ice packs, and the most careful observations were made at brief intervals of heart action, pulse, respiration, blood pressure. Slowly her body temperature went down—down as low as 90 degrees; it was not allowed to go lower. The combined actions of preliminary anesthetic and cold kept the woman slumbering painlessly for many hours. Removal of the ice and very slow warming successfully lifted her again into the world of awareness. She recalled nothing. A great discovery had been made. It is possible, and under appropriate conditions with the suitable patient it is safe, to lower the body temperature to a level hitherto universally believed lethal. Pain was relieved for days. There was a slight improvement in the general condition of the sufferer. No effect on the tumor was noted. More prolonged refrigerated slumber, at lower temperatures, was in order, with hope of greater benefit.

Dr. Temple Fay introduced medical scientists to treatments established upon a new plane of being—existence at low temperatures. Efforts are now being made to standardize procedures, hospital after hospital opening clinics of general crymotherapy.

IN one standard procedure, as tentatively adopted by the Crymotherapy Clinic of the Lenox Hill Hospital, New York City, the patient is given narcotics the night before crymotherapy is to start, another drug in the morning, and a final sleep-inducer to take away all consciousness, as a prelude to his voyage of cold in a specially equipped, air-conditioned room where the temperature is maintained at 55 degrees, Fahrenheit. He is laid naked on a bed, a thermocouple used as a thermometer is attached, and his wrists and ankles are padded and bound. About the trunk, from shoulders half way down the thighs, cracked ice is packed. After a couple of hours, or when the thermometer dial registers 90, the ice is removed. Body temperature continues its fall in the chilly room. Now 10 degrees, or even 18 degrees, below normal is considered safe. If there is too great a drop, blankets and bags of tepid water are used for warming. If there is a rise, ice bags are used. With a nurse in constant attendance, every half hour, day and night, the temperature, pulse,

blood pressure, and respiration are charted. The telephone summons a physician in the event of any marked change.

Every hour, a solution of salt and glucose is instilled through a stomach tube. Twice daily the stomach is siphoned out, and once daily is washed with salt water. Every 12 hours, the bladder is drained.

Though quite painless, refrigerated slumber is not altogether peaceful. Usually there is continual shivering, though the cold is not felt by the slumberer, and restlessness is often marked. Fleeting moments of awareness sometimes permit contact with the "frozen" mind, and in infrequent instances simple questions can be answered, dazedly. Yet, invariably, after the therapy there is no recollection of the days of cold. If dreams have flitted through the chilly dark, they are forgotten. The crymotherapeutic state is as close to temporary death as is physiologically possible to go. No drug or anesthetic so profoundly reduces all basic bodily processes. It is said that no patients have, in retrospect, regarded the treatment as unpleasant, though some complain of ill-defined pain upon being brought back to consciousness.

RATE of use of energy, or basal metabolism, is lowered during the cooling. Arteries, veins, and lesser blood vessels are astonishingly contracted, and the blood is withdrawn deep into the body, away from the chill. The pulse is slowed, perhaps down to 50 from the normal of about 72 throbs per minute. Cancerous growth, caused by cell multiplication, is probably stopped for the time, but not permanently. The profounder alterations of body physico-chemical reactions are as yet unknown, but such changes must occur; increased understanding here will lead undoubtedly to many medical advances.

When the period of refrigeration is terminated, operation of the air-conditioning system is suspended. The room temperature rises. The patient is covered with blankets. Very slowly, through six to eight hours, the body temperature ascends to normal. Rarely, there is an after-fever for a day or so.

Of course, there are dangers. but they are not as great as might be imagined. Bed-ridden patients are not good risks, nor are the anemic. Pneumonia incidence is low—provided no minutest lung cancer is present. With increasing knowledge of reactions, dangers will undoubtedly be much diminished.

With cancer primarily in mind, conservative Dr. Fay explains: "Refrigeration must be recognized as merely another physical agent with potentialities of cellular destruction if properly applied. . . We have some indication at the present time that 60 degrees, Fahrenheit, is sufficiently cold to produce definitely progressive influences on certain tumor tissues. There is a limit, however, to which the temperature of the human body can be reduced—70 to 75 degrees. Whether the spread and growth of carcinoma can be permanently influenced remains to be seen."

General crymotherapy has already proved its value in reducing extreme pain in many different conditions as well as in cancer. The pain always returns, but sometimes not for a month or two. Is it a wonder that at least one patient, temporarily relieved by crymotherapy after long months of intense suffering, asked: "When can I have another go?"

Because alleviation of pain has, in the majority of trials made thus far, been sufficient to justify dispensing with the previous regular administration of narcotics for varying lengths of time, a natural step has been experimentation in addiction to narcotics. Several apparent cures have been brought about, the patient passing the period of deprivation of his morphine in refrigerated slumber, and afterward seeming well able to endure life without drugs—despite years of chronic addiction.

The method is a "sleep" treatment, as is insulin shock for schizophrenia. Hence trial is being made in mental cases. What the future holds in this line, none can say. The probability of at least limited application appears high. Other efforts are directed against the one-celled animals of chronic tropical diseases, against acute bacterial infections of the heart, against Hodgkin's disease, wherein lymph nodes and lymph glands give rise to tumorous masses—the neck may be swollen to enormous size, for instance.

To date, eight days of unbroken refrigerated slumber has been the maximum attained. This period of hibernation can be extended, with results that cannot be guessed. Methods permitting lowering of the temperature possibly down even to 70 degrees, Fahrenheit, are believed to be on the way. Such amazing feats will have value in many practical procedures besides those already adopted. Meanwhile, we can remain convinced that an utterly new plane of life—cold life —has been given to medicine for profitable exploration.

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LIKE HUMANS

Bacteria Have Their Own Periods of Weakness

BACTERIA no less than men are subject to the laws of heredity, giving rise to countless generations of bacterial "tough guys" as well as physical weaklings. Dr. Harvey C. Rentschler, director of research for the Westinghouse Lamp Laboratories at Bloomfield, New Jersey, has verified this fact through research to collect data on the bactericidal action of ultra-violet radiation.

Laboratory tests and experiments which have been made over a period of two years has disclosed and authenticated other new biological facts of bacterial life. Bacteria vary in strength according to the stages of their life cycle, the scientist says. During a bacterium's weakest moments it is eight to ten times less strong than during its most healthy period of life.

"This variation is considerably greater than was suspected and must be seriously considered in making any tests to determine the effectiveness of bactericidal agents," Dr. Rentschler states. "In working with an ordinary culture of bacteria," Dr. Rentschler continues, "it was found that the lethal ultra-violet radiations for different individual bacteria in the same stage of their life cycle may be different by as much as threefold." It is now indicated that the deadliness of bactericidal agents is not only dependent upon the family of bacteria being killed, but also upon whether or not the bacteria are young, middle aged, or decrepit, as well as upon the definite strain of organism.

These experiments and others which were carried out to even greater lengths, demonstrated that some bacteria were more resistant than others and that the "tough guys" passed on their vigor to their children and grandchildren and on down the line.

Electrical Gold Mining

Giant Dredge and Gold Recovery Plant Are Gleaning Gold Near Famous Comstock Lode

NEW in magnitude, yet old in conception, is the "electrical miner" that is now taking 19-ton bites in the gold-bearing gravel of the historic Nevada ghost-town of Dayton. Proof of the age of its conception will be found on page 260 of this issue where, under the heading of "50 Years Ago in Scientific American," will be found a brief description of a similar "miner" that was in operation half a century ago.

Nineteen tons of gravel in one big bite—and the placer gold miner of yesteryear, working by hand, took one shovelful at a time. Twenty thousand tons—40 million pounds—in one three-shift, 24-hour working day. That's more "pay dirt" than 1000 average hand miners of yore could turn over with pick and shovel, and wash in their crude sluice boxes, in a week.

That's the story of the "electric miner" which is seeking, in 20th Century fashion, flecks of the precious yellow metal which Dayton's hardy—if transient—miner folk of 75 years ago sought with pick and shovel, gold pan and sluice.

The "electrical miner" of today is, in reality, two separate machines, P. S. Crocker, superintendent of the Dayton Dredging Company recently explained. One is the gold recovery plant—the largest of its kind in the world—which floats on a small artificial pond created by pumping water from nearby wells. It contains the washing and jigging apparatus that gleans the flakes of gold. The other machine is the "walking dragline," which resembles a power shovel as it scoops up 10-ton loads of gravel as far away as 150 feet and delivers it to the recovery plant.

A crew of half a dozen men operate the "electrical miner." In the recovery plant, most of the work is done by 24 Westinghouse motors and gear-motors, which in one day can supply power to recover the gold from 15,000 cubic yards of gravel.

"Heart of the operation," Mr. Crocker said, "is the floating gold recovery plant. This is simply a vast, efficient, modern version of the old gold pan, the sluice box, and the 'riffles' by which the hand miner of yesterday captured little flakes of gold in quicksilver."

Gravel from the dragline bucket is dumped into a hopper at the front end of the recovery plant. "Grizzly bars" across the mouth of the hopper prevent the entry of oversize rocks and boulders. The smaller material — gold-bearing sand and gravel—passes into a huge steel cylinder called a trommel, which is nine feet in diameter and 60 feet long. The trommel is placed on a slight slant and is revolved slowly by a 125-horsepower gear-motor, said to be the largest motor of its type ever employed in the washing plant of a dragline dredge.

In operation, a 150-horsepower motor pumps high-pressure streams of water through half a hundred nozzles and onto the sand and gravel passing through the trommel. More than half the cylinder's 60-foot length serves literally as a "sieve," through the holes of which pass gold-bearing sand and pieces of rock and gravel one-half inch in diameter or smaller. Larger pieces travel to the end of the trommel and fall onto the conveyor belts of the caterpillar-like "stacker" at the rear end of the plant.

Sand and gravel passing through the holes in the trommel go to concentrator devices called "rougher jigs," in which the material is continually shaken. The shaking serves to settle the heavier, gold-bearing material to the bottom, where it is drawn off as "rougher concentrate" into a concentrate sump. The lighter, hence non-gold-bearing, material from the jigs

A view of the gigantic "electrical gold miner" with its bucket, capable of taking a 19-ton bite

goes to the stacker, thence to the gravel pile.

From the concentrate sump, the rougher concentrate is conveyed to a "cleaner jig," in which the shaking process is repeated. Rejected materials from the cleaner jig go overboard. The concentrate goes next to the "amalgamator," where mercury combines with the gold to produce an amalgam. The amalgam is taken periodically to retorts on shore, where it is heated, the mercury passing off as vapor. It is then condensed for use again. The gold remaining in the retort after treatment is shipped under guard to the U. S. Mint in San Francisco.

Some gold may be left in material which is rejected by the amalgamator. This may include small pieces of quartz, for example, containing concealed or partially concealed particles of gold. Such material is washed over "rubber riffles," in the pockets of which mercury combines as amalgam with some of the remaining gold.

The remainder is fed to a "ball mill," which is rotated by a five-horsepower motor. The ball mill contains hundreds of chrome steel balls about an inch in diameter. As the mill rotates, these balls crush whatever gold-bearing rock remains. The resulting substance is washed over more rubber riffles, and the remainder of the gold is amalgamated with mercury.

Such is the method by which modern miners are extracting gold from the earth, where hand methods would not pay out. Here, on the edge of the famed Comstock Lode mining country, this mechanical monster is chewing away at the rate of 19 tons to the bite. Tomorrow—a tomorrow not too far in the future—the site of Dayton, Nevada, will be one vast stretch of gravel, and then the sage brush and prairie grass will reclaim it.

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Pulling the Wool Off Your Eyes

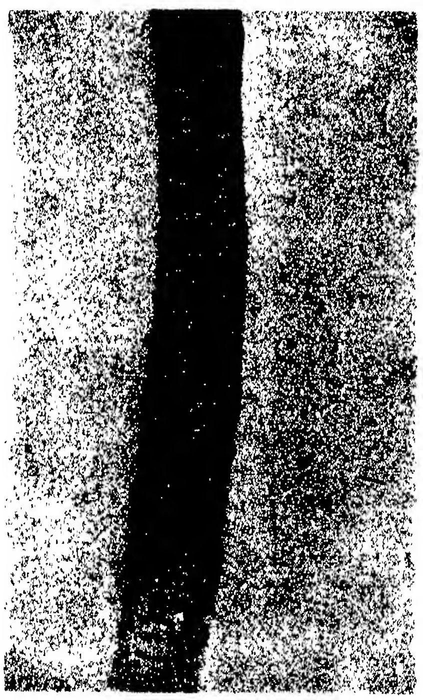
New Federal Law Defines "Wool," Sets Up Standards for Labeling Fabrics Honestly

As a descriptive phrase, "all wool and a yard wide" is all right as far as it goes—but it does not go far enough. So Congress has just enacted a law that defines just what wool is and which requires that all articles made of wool, from a pair of socks to a blanket or a suit of clothes, be labeled to set forth the exact wool or other fiber content.

The law provides that the term "wool" means virgin wool; that is, new wool just as it is produced by nature. The individual fibers of virgin wool are relatively long, unbroken, resilient, and lively. These characteristics are important because they give the fabric beauty, unexcelled tailoring qualities, and, most vital of all, long wearability. Because the fibers are undamaged, they retain their natural thermal qualities, and afford the protection against extremes in temperature which virgin wool alone can give. A garment of virgin wool holds its shape and is not easily wrinkled.

Reprocessed wool is defined as wool that has been fabricated, but which has never been used by the consumer, and reclaimed wool is wool which is reclaimed from clothing or other articles that have actually been used. These materials, before being re-spun and re-woven, must be torn up into a fibrous mass. This tearing process inevitably damages the fibers and makes them relatively shorter, weaker, less resilient. As a consequence, fabrics containing reprocessed or reclaimed wool have poorer tailoring qualities, hold line and pressing less readily, and afford less wearability than comparable fabrics made of virgin wool. Because reclaimed or reprocessed wool fibers have been damaged, their natural thermal qualities are impaired, and clothing made from them provides appreciably less protection.

A fabric made of any of these fibers, or of any variety of combinations of them, may be "all wool and a yard wide," but there would be a vast difference in quality. Or the fabric might not be actually "all wool," for the old woolen rags that were reclaimed may have contained liberal percentages of cotton, rayon, or other fibers, and of course these would go right into the new fabric. The use of cotton, rayon, and other adulterants in products implied to be of virgin



Left: A strand of virgin wool, magnified 1000 times, showing unbroken form and the scales that give it the qualities needed for durable fabrics. _Above:_ A strand of reprocessed wool, at same magnification. Note absence of scales and broken, torn condition of the fiber, making for poor wearing qualities

wool has been constantly increasing in recent years. In the most recent year for which comprehensive figures are available, manufacturers of wool fabrics used 220,000,000 pounds of clean virgin wool, but mixed in with this were 80,000,000 pounds of cotton, 70,000,000 pounds of rayon, and 114,000,000 pounds of reclaimed and reprocessed wool. In other words, of all the products offered to the public without qualification as wool, over half the fiber content was other than new, long-wearing virgin wool!

Members of Congress themselves got a sample of what the consumer is up against when they undertook to write the legislation. Among the witnesses called before congressional committees was Curt E. Forstmann, president of the Forstmann Woolen Company of Passaic, New Jersey. When Mr. Forstmann appeared before the committee, he took with him three suits which appeared to be identical. In fact, they were identical in every detail of spinning, weaving, dyeing, and finishing. Yet there was a vast difference, for one was made entirely of virgin wool; one was made of 50 percent virgin wool and 50 percent reprocessed wool; and the third was made entirely of reprocessed wool.

Members of Congress who inspected them could not tell one from another. They tried to tell the difference by feeling the texture, by rubbing, by pulling, and by minute inspection. Yet invariably their choices were wrong.

Then Mr. Forstmann produced some charts to show what happened in the laboratory when the fabrics were subjected to scientific tests duplicating the effect of actual wear and service. On the abrasive machine the virgin wool fabric had withstood the equivalent of several years of hard usage; the fabric containing 50 percent virgin wool and 50 percent reclaimed wool had failed after half the wear of the virgin wool fabric; and the fabric of reclaimed wool had broken through after only one fifth the abrasion. In tensile strength the virgin wool fabric withstood five times the pull that tore apart the fabric of reclaimed wool. The fabric made half of virgin wool and half of reclaimed wool had a tensile strength proportionately between the two.

The new law does not prohibit the use of reclaimed or reprocessed wool, cotton, or other adulterants. It merely requires that any wool product shall carry a single label showing by percentages the different fibers which have been employed in its manufacture. Most wool products already carry a label of some sort, showing the name of the retail store if nothing else; the law simply calls for the added factor of fiber identification. The manufacturer of the basic fiber must pass this information on to either the converter or the retailer, as the case may be, and they in turn must present it to the consumer. The retailer can use the manufacturer's label or he can substitute his own. Enforcement of the law is entrusted to the Federal Trade Commission.

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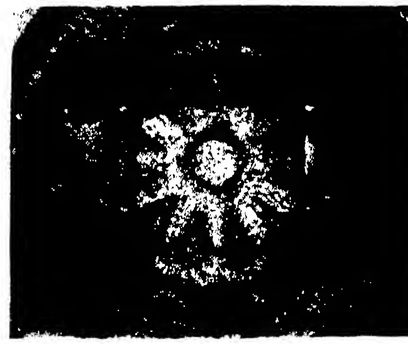
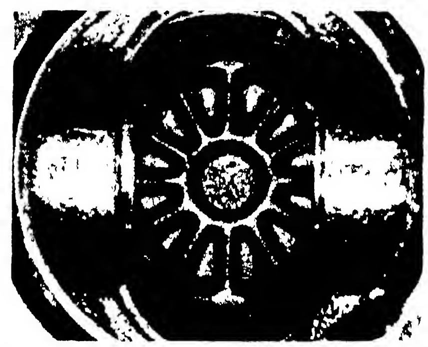
Lubricant 'Washes' the Engine

Designed for Heavy-Duty Gasoline and Diesel Engines, New Oil has Detergent Properties

A NEW type of engine lubricant, developed to overcome piston varnishing, ring sticking, and other major lubrication troubles which have limited output of many heavy-duty, high-speed Diesel and gasoline engines, just announced, marks the first time the petroleum industry has been able to offer highly "detergent" or "washing" properties incorporated in a stable, high "viscosity index" base oil. The new Essolube HD has a viscosity index of approximately 100, nearly twice that previously available in special detergent oils meeting the full range of known heavy-duty engine requirements. This new lubricant has, in addition to inherently natural resistance to oxi-



Above: **Underside of Diesel piston, lubricated with mineral oil, is heavily carbonized.** *Below:* **Piston operated under comparable conditions with new HD oil is clean, almost carbon-free**



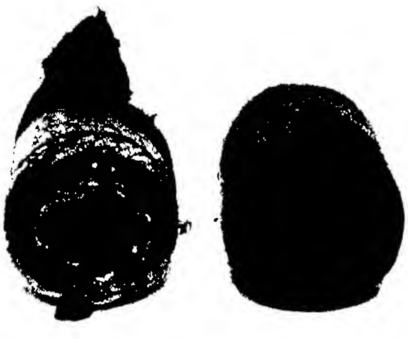
dation and high temperature, an exceptionally high ability to wash out sludge deposits, protect bearings from corrosion, and substantially to prevent deposits of varnish on pistons.

Detergent type oils in themselves are not new. Heretofore, however, oils with sufficiently high detergent properties to eliminate ring sticking, varnishing, and sludge deposits in the full range of present heavy-duty engines have had, for chemical reasons, to utilize base stocks of relatively low viscosity index. While such oils did markedly improve engine cleanliness, many engines have required, in addition, high resistance of the base oil itself to oxidation and bearing corrosion. A major problem for petroleum chemists, therefore, has been to develop an oil which, while possessing these detergent properties, had in addition the high stability usually characterized by lubricants of high viscosity index.

Viscosity index, while primarily a measure of an oil's ability to resist changes in "body" or viscosity with changes in temperature, is also a useful measure of the stability and protection furnished in service. A high viscosity index oil, by retaining its body when hot, is best able to lubricate cylinder sur-

faces and to resist leakage past rings where oil would be consumed. Laboratory evidence shows, moreover, that the stability of an oil against oxidation and heat increases, in general, with the viscosity index of the oil.

Essolube HD has been tested exhaustively in the laboratory and on the road in actual service operations. It has passed the severe General Motors Diesel test, which calls for a 500-hour run in a General Motors high-speed Diesel under full load and at full speed without oil change, and has also been formally approved by the Caterpillar Tractor Company for use in its Diesel engines, passing the well known and exceptionally severe 1000-hour endurance runs in a Caterpillar engine under both laboratory and field conditions. Essolube HD is the first high viscosity index lubricant to obtain Caterpillar approval and the first high viscosity lubricant to have passed both the Caterpillar and General Motors engine test requirements. This is said to be of particular importance since many engineers consider the requirements of these two engines so different that any one lubricant which satisfies both is well suited to the full range of present-day heavy-duty engines.



Both of these filters have gone 3000 miles. One at left was in engine using ordinary oil; one at the right filtered new HD oil

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SPRAY POISON

Kills Codling Moth Worms, Spares Bees

DEADLY to apple worms, harmless to bees, are virtues found in the new poison-spray material, phenothiazine, now being tested by the United States Department of Agriculture. The discovery is subject of a joint report by L. M. Bertholf of the Bureau of Entomology and Plant Quarantine and J. E. Pilson of Western Maryland College, according to *Science Service.*

One of the great problems involved in control of the worst of apple enemies, codling moth (whose larvae are the "worms" found in apples), is the deadliness to bees of the arsenical sprays commonly used. Beekeepers and orchardists are constantly at feud over this question.

In the tests reported recently, bees were given heavy doses of phenothiazine without any apparent ill effects. In contrast, minute doses of calcium arsenate proved deadly, and lead arsenate was also an active bee poison in the doses bees are likely to get in gathering pollen from sprayed orchards.

Phenothiazine is not yet recommended for general use in orchard spraying, because thus far it has not produced uniform results on the codling moth larvae. It is hoped that further experiments will make it more completely dependable and useful.

ANISEIKONIA

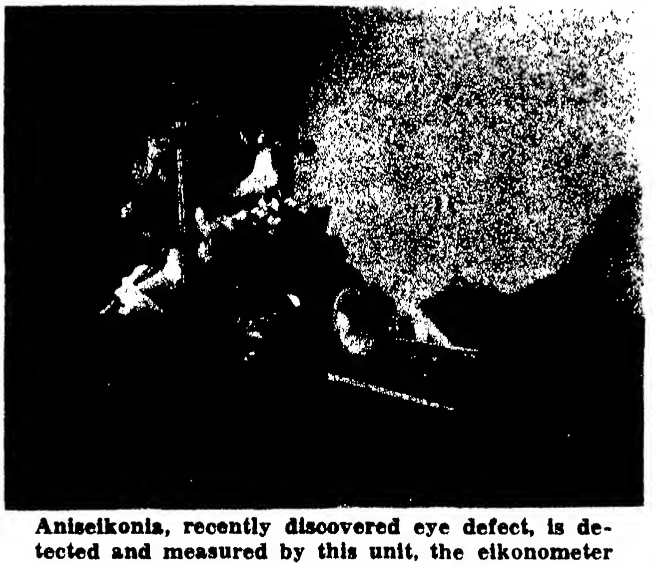
Device Detects Important Eye Defect

MANY puzzling cases of eyestrain, sick headaches, nervousness, and some traffic and flying accidents may be eliminated through the development of a new and simplified instrument to detect and measure aniseikonia, recently discovered eye defect described in a recent article in these pages.

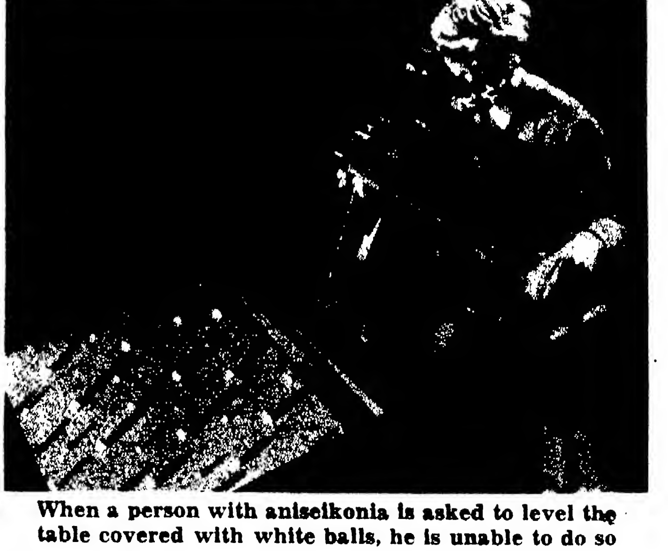
Aniseikonia, discovered by Dartmouth research scientists, causes pictures of objects received by the brain through the two eyes to be unequal in either size or shape, or both. It occurs fairly frequently. The strange eye condition may affect stereoscopic vision so that objects in space appear tilted, rotated, and distorted.

As faulty depth perception makes flying hazardous, systematic tests have been inaugurated to determine any existing relationship between aniseikonia and the flying performance of pilots.

Heretofore, it was necessary for victims of aniseikonia to visit clinics in New York, Boston, St. Louis, Baltimore, and Hanover, N. H., to have the defect corrected. Approximately 5000 cases have already been treated. Assisted by the new instrument, specially trained eyesight specialists



Aniseikonia, recently discovered eye defect, is detected and measured by this unit, the eikonometer



When a person with aniseikonia is asked to level the table covered with white balls, he is unable to do so

throughout the country will soon be in a position to make the necessary examination and correction of this eye defect.

The new test instrument measures the relative size of the two ocular images. By means of special lenses, an illuminated screen, and polarized light, chief components of the eikonometer, both eyes are trapped into revealing their comparative efficiency in transmitting images to the brain.

First, the eyes are examined for any refractive errors and corrective trial lenses are placed in the instrument. Telescopic lens systems with variable magnifying properties are also placed before the eyes.

The patient looks through the battery of lenses at an illuminated target of lines forming a cross. At equal distances from the center of the cross, four pairs of numbered opposing arrows are located perpendicular to the lines.

By means of Polaroid film the light coming from the odd numbered arrows is polarized in one direction, the even numbered in the direction at right angles. Correspondingly oriented Polaroid plates placed before the eyes permit the patient to see the odd numbered arrows with one eye, the even numbered arrows with the other.

If the four pairs of arrows are not seen in alignment with each other, a size difference, or aniseikonia, is present. This difference is measured by adjusting the magnifying lens units until the opposing arrows are in alignment. The defect is then corrected by iseikonic lenses which are so designed that they not only correct any existing refractive error but also aniseikonia.

PENCIL POINTER

Electric Driven Sharpener for Office Use

An electric pencil pointer which, it is claimed, will give substantial savings in time and pencil waste,

Points pencils automatically

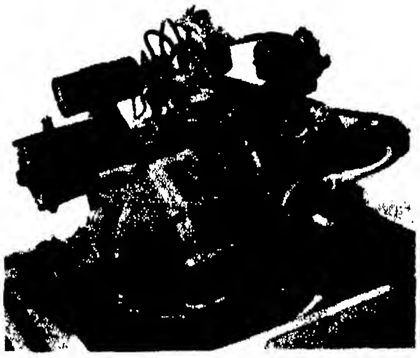
has recently been placed on the market. Known as the "Electro-Pointer" it is powered by a self-balancing, non-stalling A.C. or D.C. motor which is operated automatically when the pencil is pushed into the hole in the housing.

The unit is housed in molded black Durez, is weighted so that it will rest on a desk or table top without having to be screwed down. The shaving-receptacle drawer is large enough so that it need not be emptied as frequently as in most conventional pencil sharpeners.

INBOARD BOAT

Economical Marine Engine in Small Power Boat

An adaptation of the small gasoline engine used in the Crosley automobile has now been applied to marine use. In the design of this motor, economy has been stressed both in original cost and in upkeep. Equipped with an electric starter,



Two-cylinder marine engine adapted from automobile motor

it can be applied to small boats of various types and is also used as the power plant of the Crosley "Watersprite" shown in one of our illustrations.

In adapting the automobile engine to marine purposes it was changed from an air-cooled to a water-cooled type, the cooling water passing out through the exhaust pipe. The engine itself is of the two-cylinder opposed, four-cycle type and is claimed to use less than one gallon of gasoline per hour at full throttle, and less than one-half gallon per hour at cruising speed. Horsepower rating is approximately 10 at the recommended maximum engine speed of 3000 revolutions per minute. The total weight, including the electric starter, is only 190 pounds. The

"Watersprite", plywood boat that uses new engine described

motor has a 3 inch bore, 2½ inch stroke, displacement of 33.5 cubic inches, a compression ratio of 5 to 1, and a crankcase oil capacity of 2½ quarts.

The hull of the "Watersprite," the boat for which this motor was specifically designed, is made of plywood, four layers being molded into plastic form with a phenolic water-proof resin glue. There are no seams in the hull, which has been molded with a reverse flare to give additional speed and to deflect water from the sides of the boat.

HEARING AID

Vacuum Tube Amplifier Used in New System

Not only is sound amplified far above its normal intensity, but various portions of the musical range can be amplified by different amounts by a new vacuum tube hearing aid recently announced by the Western Electric Company. With these decided advantages for the hard-of-hearing, tones which are normally heard very poorly can be clearly reinforced, and those which are heard fairly well may be amplified only a small amount. Thus it is possible for the Orthotronic Audiphone, as the new instrument is called, to compensate admirably for individual types of hearing deficiencies. A further advantage is that the circuits are so designed that nearby voices or distant sounds are amplified only sufficiently for the purpose, the "shock effect" of loud noises being eliminated.

This last advantage also gives the wearer control in noisy places against the possibility of certain noises being amplified and interfering with the desired sound. By flipping a small switch it is possible to reduce annoying rumbles and deep vibrations while essential speech sounds pass unhampered. Another control regulates volume of the reproduced sound.

The microphone, which, with

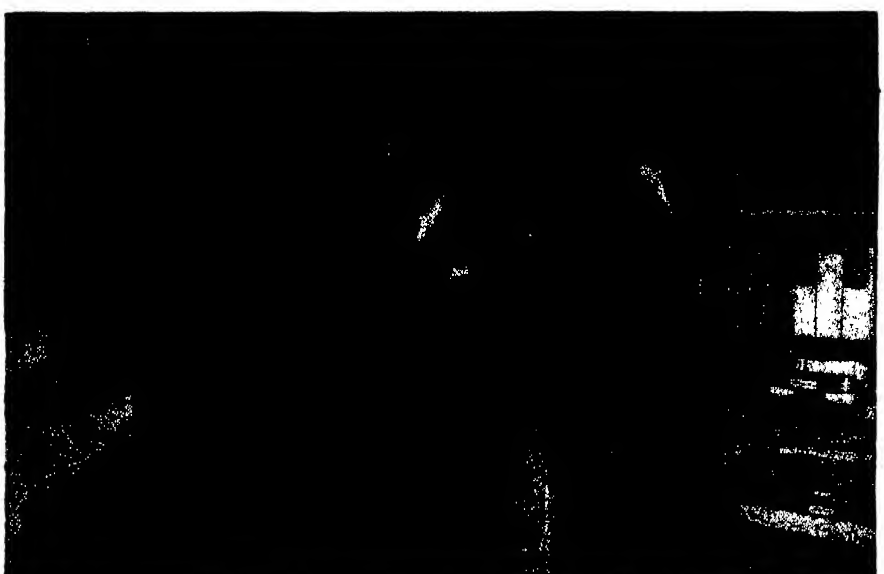
the amplifier, is contained in a housing only slightly larger than a cigarette case, is of the crystal type. The miniature receiver to which it is connected through the amplifier is of the magnetic type and may be coupled with the hearing mechanism either by the air conduction or bone conduction method. The manufacturer states that the crystal microphone is stabilized both for temperature and humidity, assuring the wearer of natural hearing regardless of extremes in weather conditions.

SALES EDUCATION

Sound Recorder Enters A New Field

INDICATIVE of the possibilities of quality sound recording equipment is the use of Presto recorders in a recent sales audition and contest held by Westinghouse. In this contest, household appliance salesmen were encouraged to prepare sales talks which were eventually recorded and then reproduced for final judging.

It would be entirely possible to extend this use of sound recorders to many other fields. Wherever it is desirable for salesmen or an executive to be able to hear his own spoken words in order to evaluate their effect, home sound recorders can serve a very definite purpose. A complete sales argument, a speech, or any similar exposition can be completely recorded and then played back as many times as desirable. Thus it becomes possible to "edit" the material before it is finally used for its intended purpose. These recorders, as now available, can be used by anyone, regardless of technical training; they are almost as simple to use as is an ordinary phonograph.


Recording a sales talk for future reference

PENCIL BLUEPRINTS

New Drawing Medium for Draftsmen

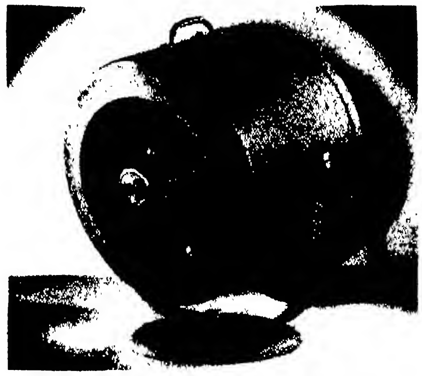
BLUEPRINTS and Blacline prints made from pencil drawings on a new transparent medium are as sharp and clean as those made from conventional India-ink drawings on tracing cloth. This new medium, not a tracing cloth and not a vellum, has astounding strength and body, is moisture-proof, and is lower in cost than conventional drawing mediums. Due to the surface of this Post Tracing Medium, as it is called, pencil detail is as opaque as if drawn in ink. Coupled with this is the extreme transparency of the medium, both contributing to the quality and sharpness of the final printing results.

Standard 20-yard rolls of this material are available in widths from 30 to 54 inches; it may also be had in sheet form.

UNIT HEATER

Fan and Heater in Compact Housing

FOR year around use in office and stores, a new fan-type all-electric unit heater is now available in two, three, and four kilowatt sizes at 115 and 230 volts A.C. The units have an output of 7000, 10,000, and 14,000 B.T.U. per hour respectively.


Heater and fan in one unit

The all-metal heaters are cylindrical in shape, with a swivel bracket designed for both vertical and horizontal adjustment. The overall dimensions are 16¼ by 13¾ by 11½ inches deep.

A Westinghouse Corox heating element is used to give long life, dependable performance, and economical operation. The switch for winter operation controls both heating element and fan, and a bimetal thermostat removes motor and heater from the line in case of overheating. The fan operates independently for summer use as an air-circulating unit.

Smooth and quiet operation is assured by special motor and fan construction. Baffles direct the flow of incoming air over the motor and protect it from radiant heat. Unusually wide fan blades assure maximum air delivery against any possible back pressure.

SOLID SHOT

Believed Effective Against Tanks

BECAUSE of the increased thickness of armor on tanks, armies of the world have developed larger and still larger guns to combat them. Needless to say, the cost of operating these larger guns, with their much larger shells and explosive charges, has increased enormously. Brig. Gen. R. H. Somers, of the U. S. Army Ordnance Department, suggested recently that smaller guns firing solid shot would be just as effective and a great deal less expensive to operate.

Those who have examined tanks at close quarters can easily understand how one solid shot, once it

penetrates the "cabin" of a tank would certainly cause damage. That small compartment must accommodate not only the driver, the tank commander, and one or more gunners, but it must also have all the controls and the magazine containing all ammunition. A solid shot would find numerous vulnerable parts which it would put out of action. It is believed, further, that a solid shot would do serious damage to the treads or to any exposed engine parts.

RACE CAR

Uses "Pump" Gasoline, Breaks Speed Records

FOR years it has been taken for granted that highly doped and blended gasoline is used by the daring race drivers who crack speed records. Most of these fuels contain only about 10 percent actual gasoline, the balance being benzol, alcohol, and plenty of "ethyl." But George Barringer and his experimental Miller Special, shown here, have proved that records can be broken with ordinary service station or "pump" gasoline in the tank and regular motor oil, not castor oil, in the crankcase.

On Utah's famous Bonneville Salt Beds, Barringer cracked 14 international records and set 19 new American marks (certified by the Contest Board of the A.A.A.) with his rear-engined speedster. All records for Class "D" racing, from 5 to 500 miles were broken, not by small margins, but by a minimum of 18 to a maximum 32 miles per hour. The 142.799-mile clip for 500 miles is almost 25 miles an hour faster than the Indianapolis Speedway record for this same distance. The low-slung racer was specially designed by Harry Miller, dean of Indianapolis builders, to use conventional gasoline and oil, and was built by the Gulf Research Laboratory at Harmarville, Pennsylvania.

Rear-engine race-car uses ordinary "pump" gasoline efficiently

Carburetors and supercharger of the Miller rear-engine race car

The car is built almost entirely of aluminum. Its six-cylinder supercharged engine is placed in the rear. Combined with a four-wheel drive, this engine has sent the racer roaring along at speeds of nearly 160 miles an hour.

Miller selected a six-cylinder engine for the power plant because it would combine smoothness and simplicity. The 529.5-pound motor has a displacement of 183 cubic inches and develops over 1.35 horsepower per cubic inch. This is about three times the power of the average stock engine.

In order to provide for quick dissipation of heat and to reduce weight as much as possible, the motor block is of cast aluminum. The engine is of the usual Miller design, using two overhead camshafts, gear driven from the crankshaft. No rocker arms are used, the cams acting directly on the followers which are mounted in contact with the valves. Babbitt bearings are used.

The supercharger is of the centrifugal type designed by Miller; the nine-inch impeller is driven at 34,000 revolutions per minute at the engine's top speed of 7000 revolutions per minute. Two carburetors serve the supercharger, and air is taken in direct from outside the hood.

The car's performance with conventional No-Nox gasoline and Gulfpride motor oil leaves little to be desired. Even though the compression ratio is very high (12.5:1), there has been no trace of knocking. Still more remarkable is the condition of the engine after the many gruelling tests at high speed. Pistons, valves, sleeves, rings, and bearings show hardly a sign of wear or deterioration.

Cost of operation is considerably reduced by the use of service station gasoline which costs from one-half to one fifth as much as "doped" fuel. The castor oil compounds, which last only a few hours, are supplanted by conventional motor oil which can be used for months.

FIRE AID

Seals on Extinguishers Keep Them Always Ready for Use

THE NATIONAL need for uninterrupted production demands that fire extinguishers be kept ready for emergency use. They must not be tampered with. After use, they must not be returned empty to their brackets. They should be inspected often.

To facilitate frequent inspection and to tell at a glance whether pump type extinguishers have been tampered with or used, Gardeseals have been introduced by the Pyrene Manufacturing Company. These seals, placed over extinguisher handle and bracket, are bright red, visual signals that are destroyed the moment an extinguisher is taken from its bracket. Gardeseals, easily applied by soaking in water and placing over handle and bracket, shrink to a tight seal in an hour.

An easily broken seal between fire extinguisher and bracket shows instantly whether extinguisher has been used

HORIZONTAL WELLS

New Technique Taps Oil Sources

HORIZONTAL drilling of oil wells, after 25 years of working out the problems involved, at last appears to be an accomplished new technique of the petroleum industry, bringing materially increased oil production from certain types of

fields, and offering promise of further extension in the future.

The first horizontal well, drilled into an outcrop in a creek bed in Ohio, penetrated an old field where engineers reported that no oil could be recovered by conventional vertical drilling. After this well had been on production for six weeks, it is stated, it was producing oil at a rate greater than the combined total of the nearest 50 producing vertical wells in the field.

Success of the well encouraged the sinking of a large vertical shaft, from the bottom of which six horizontal wells have been drilled. The wells were drilled in diametrically-opposite pairs, two at a time. The same set of tools was used for each pair of wells; the operation of pulling the drilling rods out of one hole to change the bit moved them into the opposite hole for drilling.

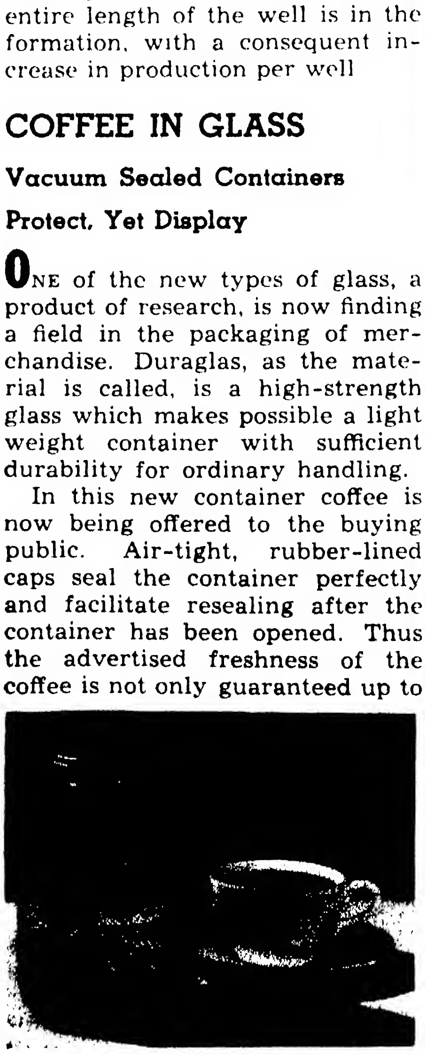
Advantage of horizontal drilling, in the shallow fields where it now may be applied, obviously lies in the fact that instead of having only a small portion of the well hole actually in the oil formation, the entire length of the well is in the formation, with a consequent increase in production per well

COFFEE IN GLASS

Vacuum Sealed Containers Protect, Yet Display

ONE of the new types of glass, a product of research, is now finding a field in the packaging of merchandise. Duraglas, as the material is called, is a high-strength glass which makes possible a light weight container with sufficient durability for ordinary handling.

In this new container coffee is now being offered to the buying public. Air-tight, rubber-lined caps seal the container perfectly and facilitate resealing after the container has been opened. Thus the advertised freshness of the coffee is not only guaranteed up to



Glass — yet light, strong

the time of purchase but also while the container is in the home.

Although coffee has been merchandized in glass containers in the past, the new Owens-Illinois technique of manufacturing Duraglas presents the advantages of lightweight containers which materially reduce the shipping costs.

Photograph at left was taken at 9 A. M., one at right at 12 noon. In the elapsed three hours the laminated wood culvert was completely installed

CULVERTS

Laminated of Pressure-Creosoted Wood

INEXPENSIVE culverts that can be rapidly constructed of prefabricated wood members are finding increasing usage in railway construction, highway design, airport drainage, in waste and storm sewers, and in other locations where their relative freedom from maintenance problems is a desirable feature.

These culverts are made up of pressure-creosoted wood members which are assembled by unskilled labor at the point where they are to be used. Interlocking features make it possible to install a culvert with a minimum loss of time. An accompanying series of illustrations show a culvert that was completely installed in three hours.

The prefabrication of the sections used is accomplished by nailing the individual members into laminated sections up to four feet in length. Side, top, and bottom sections interlock and are field erected without the use of additional hardware. The design is such that every member in the side sections has a bearing surface for every top and bottom member, thus insuring maximum strength.

These laminated culverts have sloping head walls and underground curtain walls at both ends, thus preventing erosion, backwashing, and overflow. It is stated that the pressure-creosoting of the wood used results in exceptional durability.

PLANETARIUM

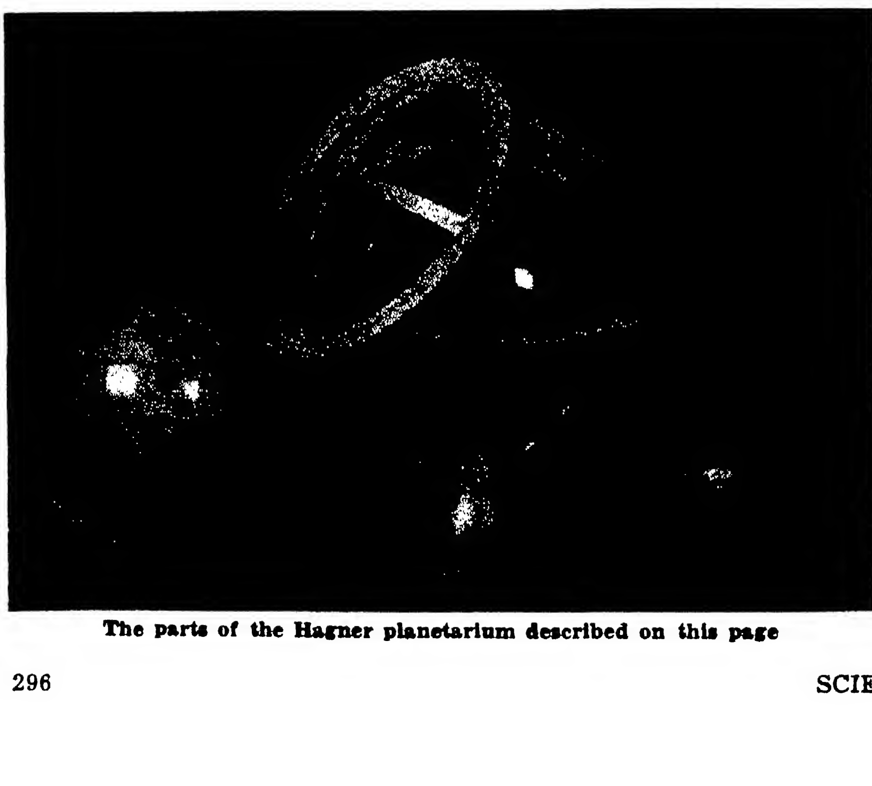
For Navigation Studies and the Astronomy of Position

WHAT is believed to be the first basic advance, in several centuries, in devices to simulate the movements of celestial bodies and their relation to terrestrial phenomena has been developed by Fred Hagner, of San Antonio, Texas, who previously invented the Hagner Computer, now in use by the United States Army Air Corps for air navigation.

The new instrument, the Hagner Planetarium, is designed to facilitate a grasp of the principles of nautical astronomy, in their application to problems of celestial navigation, but the device also may be set to solve the astronomical (spherical) triangle, inherent in all off-shore or air navigation "arguments."

The planetarium consists of an assembly of metallic rings and arcs, graduated in hours and fractions, and degrees, according to their respective functions; a horizon, or azumith disk, the center of which represents the position of the observer and the periphery of which represents the observer's horizon; and two globes, one terrestrial and one celestial (star), which are interchangeable in the frame with each other, and with the azimuth disk.

Some of the functions of the planetarium are: Identification of stars and constellations, the names of which may be read direct through a sighting tube, after the proper settings have been made on the arcs concerned; determination, in advance, of stars that will be visible above the observer's horizon at a given hour of local time in a given latitude; measurement of the Sun's altitude; determination of true north, to check compass error; computation, mechanically, of a line of position for mariners; reproduction of the Sun's motion at different seasons; demonstration of differences in lengths of days in various places; times of sunrises and sunsets at different points on the Earth; differences of time in different cities at any given instant; determination of correct local time at any instant; demonstration of beginnings and endings of seasons.



The parts of the Hagner planetarium described on this page

ODOR ADSORBERS

Reduce Air-Conditioning Costs

BECAUSE the new outside air introduced in air-conditioning sys-

tems consumes the bulk of the conditioning energy, modern systems are being designed to recirculate a maximum of the total air circulated. This maximum is, however, limited to the health and comfort of the occupants — which requires from 15 to 30 cubic feet of pure, odor-free air per minute per person. By applying odor adsorbers to the recirculated air, it becomes possible to reduce the outdoor air supply to from three to five cubic feet per minute per occupant (more than ample for oxygen requirements) and thereby provide air-conditioning comforts at considerably reduced air-conditioning costs.

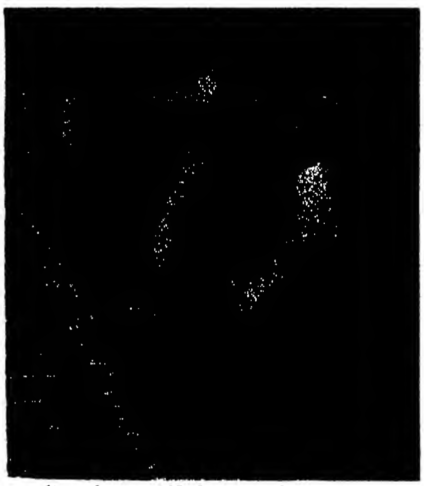
Savings of this sort, afforded by odor adsorbers such as the Dorex type, are frequently as high as $160 per annum for each thousand cubic feet reduction in outside air, or over 100-percent annual return on the cost of the odor-adsorbing installation. These installations may be applied to existing as well as new air-conditioning systems.

Dorex odor adsorbers are the commercial application of the gas-mask principle. Employing specially processed, highly activated coconut shell carbon, they adsorb, or, more simply, extract and hold, odorous gases and vapors in a condensed state. Upon saturation the carbon may be economically reactivated and re-used.

RUBBER TRACKS

Efficiency of Army Tanks Increased

When the modern mechanized army rushes over all manner of rough terrain on "caterpillar" tracks, anything that can be done to contribute to the efficiency of the



Comfort, efficiency, for tanks

equipment or of the operating crew is highly desirable. Rubber is now playing its part in this respect. By cushioning tank treads with rubber blocks it is possible to reduce the wear and tear on the tank itself, to operate the tanks at higher speeds on paved roads, and to contribute a certain amount of comfort to the crew.

One of our photgraphs, taken in a factory of the Goodyear Tire and Rubber Company, shows tank track blocks with these rubber pads attached. It is said that thousands of these blocks are being manufactured under sub-contract for manufacturers of Army tanks.

TRAFFIC LINES

Glass Beads Increase Night-Driving Safety

ANY way in which the visibility or effectiveness of the traffic stripe on highways can be increased during the hours of darkness, will make a worthy contribution to highway safety.

One method, which is now being experimentally employed in California, uses glass spheres or beads to reflect headlight beams and hence to make the traffic stripe more visible. The process of application is quite simple. A bead dispensing machine is placed directly behind and approximately 18 inches away from the spray nozzle of the paint rig. When in motion, the rubber tired wheels of the machine turn a fluted cylinder in a hopper, which, by gravity, feeds the glass spheres onto the wet paint. As the lacquer dries, the beads become embedded and firmly locked into place.

It is not necessary to clean traffic lines when painted with beads. Any small accumulation of road dust collected between the spheres is quickly removed by the action of traffic.—*California Highways and Public Works.*

EXTRUSION DIES

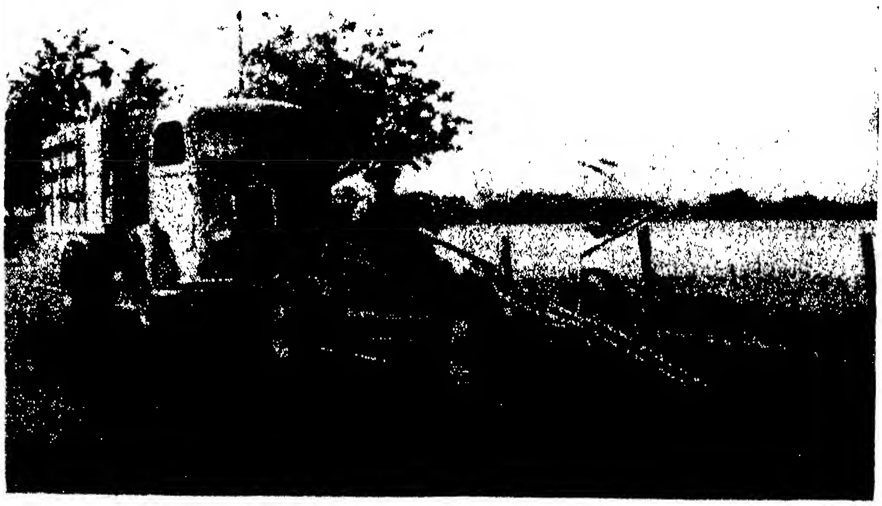
Graphite Lubrication Improves Product, Protects Dies

TO INCREASE the number of "pushes" between successive redressing operations on extrusion dies, Revere Copper and Brass, Incorporated, is using "dag" colloidal graphite as a lubricant.

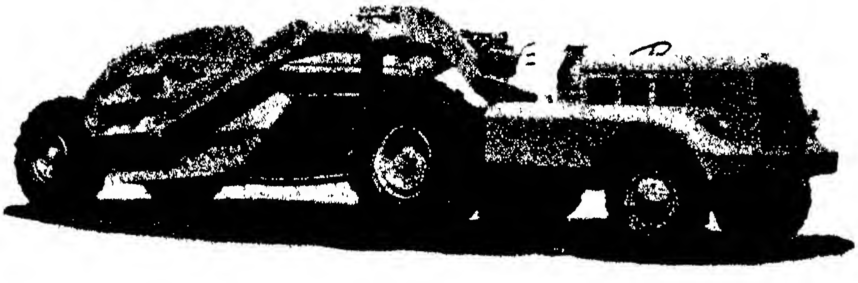
Extended tests have shown that by using this form of lubricant it is possible to increase the number of pushes by an average of 20 percent; of even greater importance is the fact the improved surface obtained with graphite-lubricated dies will effect a considerable reduction in scrap produced by unsatisfactory surface conditions in the extruded products.

The method of applying the graphite to the dies is simplicity itself. Each time the dies are removed for redressing, they are coated with a graphite dispersion using an ordinary spray gun. The dispersion is made up from the Acheson colloidal graphite concentrate, thinned with distillate of 200-second viscosity. This is suitable for dies that are still warm from use. When dies are cold, the dispersion is thinned further with carbon tetrachloride.

The sections produced by the extrusion process range from various architectural shapes, such as window frames, sills, angles, T's and Z's, to thin ribbed and corrugated forms suitable for moldings and



Applying white lacquer and glass beads to a traffic stripe



New rubber-tired tractor and versatile scraper

cover strips. Use of the colloidal graphite has proved of greatest importance with the thinner sections where the decorative value of the product may require a consistently smooth, bright finish.

LIGHT CURRENTS

Electric Potential Set Up in Light Beam

A POWERFUL beam of light can act as a battery, so that electricity can be collected from it at two different points. This is indicated by the experiments of Dr. Felix Ehrenhaft, Director of Physical Institute of the University of Vienna in the days before Austria ceased to exist.

The experiments were made by watching the behavior of minute particles which floated in the air in the path of the light beam, reports *Science Service*. The particles were surrounded by an electrical field and sometimes they moved towards the light, sometimes away from it. This was due, Dr. Ehrenhaft believes, to the interaction between the field of the beam itself and that induced around it. Similar effects were obtained with magnetic fields, showing also that the light beam is magnetized.

From these studies he concludes that along the beam at different points there must be differences of electrical potential, as there are between the terminals of a dry cell, though far smaller. Thus, theoretically, it would be possible to insert electrodes into the beam at different places, and draw current off, though it is difficult to imagine how such minute currents could be detected.

SCRAPER

Handles Materials From Sand to Gumbo

A NEW, high-speed, hydraulically operated scraper has been announced by the LaPlant-Choate Manufacturing Company, Incorporated, engineered and designed for use with the new rubber-tired tractor which the Caterpillar Tractor Company is making available. It is a high-speed scraper which loads, transports at speeds up to 18 miles per hour, and spreads earth or other material under its own power. It is free from overhead obstructions so that it can be loaded by dragline or shovel, if desired.

Finger-tip hydraulic control of the scraper matches the hydraulic brakes and steering of the tractor. Hydraulic rear wheel brakes on the scraper are operated simultaneously with the brakes on the tractor. A low center of gravity and correct balance eliminate bobbing, weaving, twisting, and the danger of jack-knifing. This also adds to the comfort of the operator. The bowed design of the cutting edge make loading easier and faster; the guide arrangement insures correct operation of the rear ejector gate.

Extremely important is the honeycomb construction of the bowl bottom, an exclusive feature which means much greater strength and rigidity. Another "exclusive" is the independent apron operation. This permits uniform spreading of any material from sand to gumbo.

POWER ALCOHOL

Would be an Additional Tax on Consumer

SPORADICALLY there crop up attempts to introduce alcohol as a motor fuel in the United States, most of the attempts being based on the assumption that the alcohol would be made from domestic farm products and hence would constitute an additional source of revenue to the farmer.

The subject of power alcohol has been carefully studied by the Committee on Motor Fuels of the American Petroleum Institute and this or-

ganization recently released the following pertinent conclusions:

"The power alcohol idea has been under consideration for over 30 years but is no more practicable today than it was at the beginning.

"Alcohol cannot be manufactured from farm products under present and prospective conditions for less than five to six times the cost of gasoline.

"Mixtures containing 10 percent of alcohol would consequently cost around three cents a gallon more than straight gasoline.

"Use of a 10 percent mixture would increase the nation's fuel bill by $690,000,000.

"The claim that technical advantages of alcohol-gasoline fuels justify their extra cost is not supported by facts.

"Europe's experience with alcohol mixtures, instead of proving their value as proponents have claimed, showed clearly that the scheme is not economically sound.

"Because farmers buy one-fourth of the motor fuel consumed, because relatively few could actually sell products to alcohol distilleries, and because of adverse influences on sales of other products, on soil fertility, and on independent farming, the net effect of the power alcohol scheme on farmers' interests would be adverse.

"Pretensions that alcohol is needed as a substitute for irreplaceable oil supplies are answered by the fact that petroleum reserves are greater today than ever before, while conservation methods are still improving rapidly. Also that methods already developed of synthesizing oil from coal assure a continuing supply of oil as far into the future as any need can be foreseen, at cheaper prices than are in prospect for alcohol."

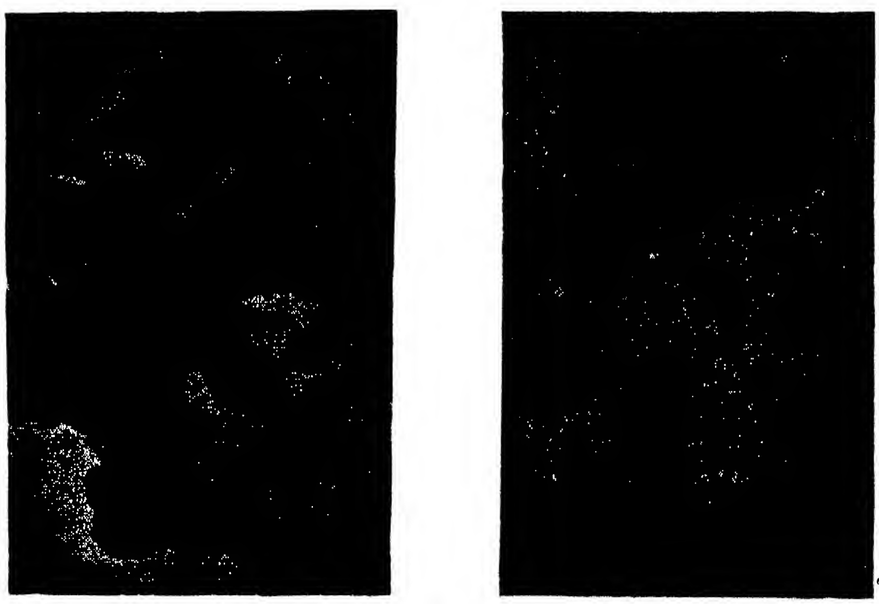
PAPER SCIENCE

Electron Microscope Reveals Differences in Coatings

PHOTOGRAPHS of paper pigments, made with the electron microscope, were shown by A. R. Lukens, C. G. Landes, and T. G. Rochow of the American Cyanamid Company to demonstrate difference between ground and precipitated calcium carbonates to the Technical Association of the Pulp and Paper Industry at a recent meeting.

Particles of calcium carbonate pigments, such as used in making the paper on which this magazine is printed, are so minute that certain significant differences in their structures escape observation with the light microscope. However, photographs taken under the extraordinary power of the electron microscope make these differences in pigments prepared by different methods clearly apparent.

Electron micrographs at a magnification of 36,000 times natural size showed that a typical precipitated calcium carbonate (precipitated chalk) is made up of tiny elongated crystalline prisms massed together to form groups having extremely porous internal structures and rough external surfaces. In contrast, a new type of pigment, called Cal-Micro and pre-



Electron micrograph at left (approximately 18,000x) shows calcium carbonate to be made up of tiny, elongated crystalline prisms. Compare definition with photo (right), made with light microscope, about 1000x

pared by a special process involving water-grinding of natural calcite rock, is shown to consist of solid, non-absorptive rhombs and fragments. Photomicrographs made with a light microscope, at 2000 times natural size, shown for comparison, failed to reveal complete details. [Photos were reduced one half for reproductions.—*Ed.*]

The important differences between these ground and precipitated pigments in use lies in the proportions of adhesive (casein) required by each to form a satisfactory coating for high-grade paper. The lower casein requirement of Cal-Micro is explained by the non-absorptive structure of its particles, the report stated.

This is the first application to paper pigments of the electron microscope, by which minute objects can be pictured at as much as 100,000 times natural size. The instrument used in this investigation is the first one commercially built in the United States.

GREAT BASINITES

Artifacts in Caves

Date Early Indians

WHILE evidence of an immediately post-ice-age culture, perhaps 10,000 years old, has been accumulating for several years just east of the Rockies, the Great Basin region across the Continental Divide remains much more of an enigma.

Dr. Julian H. Steward, of the Smithsonian Institution's Bureau of American Ethnology, explains that, immediately after the retreat of the ice, the barren land of today, deluged with heavy rains, was much more fertile and inviting to human beings. There were deep lakes and broad rivers. Windswept waves of the lakes beat against the rocky shores and created large underwater caves. Then came the dry period which, with a single interruption, has continued to the present. The lake levels sank. One after another, the caves were left high and dry, affording excellent shelter for human beings of a low culture level who seem to have drifted into the Great Basin. They left artifacts scattered over the cave floors.

Thus the present evidence, Dr. Steward says, indicates strongly that parts of the region were occupied between 10,000 years ago and the first appearance in the southwest of the Basket Makers—probably less than 2000 years ago. The story of 8000 years remains to be reconstructed from such bits of evidence as can be uncovered by the spades of archeologists.

WIRE HOLDER

Ancient Trick Applied To

Modern Purpose

A DEVICE based upon an old Chinese trick has recently been placed on the market for use in holding wires in position. As one of our photographs shows, the woven material

Wires, cables, or ropes may be suspended from hooks or otherwise by the use of simple modern version of an old Chinese trick

of the wire holder is slipped into place and suspended from a hook or other fastening. As the device stretches it tightens around the wire, holding it firmly. Telephone wires, radio aerials, or almost any type of wire, cable, or rope can be held in place by this device.

METAL USE

Increases with Greater

Applications of Plastics

ODD as it may seem at first glance, the rapidly expanding use of plastics will boost and not decrease the use of metal. The substitution of plastics for metals in certain parts of commercial and household machines will reduce costs of production substantially, according to Dr. A. A. Bates, manager of chemical and metallurgical research for Westinghouse Electric and Manufacturing Company. "The result will be increased demands for the machines, leading to a larger volume of production and use of more metal in parts that plastics cannot replace," Dr. Bates said. Recalling

the olden days, a time when the automobile was replacing horse-drawn vehicles, and comparing it with the present trend in plastics, he said that "it was then predicted that all blacksmiths would be thrown out of work, but . . . the automobile industry now employs more blacksmiths than were employed before."

"We now have plastics which, weight for weight, are as strong as steel. Since we can mold plastics into almost any shape, they simplify fabrication by eliminating many of the screws, bolts, and rivets which take up so much valuable time in the manufacturing process. Many of the plastics are also fireproof and acid resistant. Most of them are not affected by water, so that they wear longer when exposed to the weather."

Looking into the future, Dr. Bates said that the development of the airplane will probably lead to increased use of both plastics and metals. Small airplanes in which plastics are used because of their simplicity and adaptability to streamlining may have the same effect on the aircraft industry that the flivver had on the automobile industry.

"After the war is over we may expect a flood of these small planes to come off the production lines at prices that many people can afford. Commercial transports will probably continue to be made of metals for many years," predicted Dr. Bates, in conclusion.

AVIATION

Supercharging the Pilot

Aeroembolism Prevented by Pre-Flight Administration of Oxygen

ALEXANDER KLEMIN
Aviation Editor, Scientific American
In charge, Daniel Guggenheim School of Aeronautics, New York University

THE new Lockheed-built Army Air Corps interceptor-pursuit, the P-38, equipped with the 1100-horsepower Allison engines, is said to have broken many speed records and to have shown tremendous climbing ability. With new, fast bombers capable of flying at 30,000 feet and higher, and with the advent of pressure cabins, the pilots of the interceptors must be prepared to go to 34,000 feet, or higher. If the cabin of the interceptor cannot be supercharged (because of weight and performance requirements), then the pilot must be "supercharged," if he is to retain his efficiency at high altitudes, or even survive. With the advice of the Mayo Clinic, Lockheed Aircraft has recently made an experiment in supercharging its ace test pilot, Milo Burcham, and in safeguarding him against aeroembolism or aerial "bends," which are similar to bends experienced by deep-sea divers who come to the surface too fast.

Medical authorities are quite certain that man cannot long survive above 18,000 feet unless artificially supplied with oxygen. He has an even more serious weakness, however. When the pressure is lowered, the gases in his system expand. The less the pressure, the greater the expansion, and the faster the climb to high altitudes, the greater the danger to the aviator. One of the gases in the human body is nitrogen. When this expands, it forms bubbes in the tissues and blood stream, and the resultant aeroembolism connotes temporary paralysis and even unconsciousness. Since a modern pur-


Breathing pure oxygen, and exercising leisurely, the airplane pilot soon becomes "supercharged"

Still breathing oxygen, the "supercharged" pilot climbs into his plane

suit can dive to the ground at 600 miles an hour, unconsciousness for even a short period means great hazard. The case for "supercharging" the pilot is convincing, and the necessity all the more imperative when planes can climb at a mile a minute.

The Lockheed experiments with Mr. Burcham are based on a comparatively simple process developed originally by the Mayo Clinic. Before a high-altitude flight, the pilot exercises for 30 minutes. The combination of exercise and oxygen eliminates the nitrogen from the body. On the advice of the Mayo Clinic, Lockheed built a special decompressor room near its test hangar. The equipment consists of bare essentials—a stationary bicycle, oxygen cylinders, inhalation apparatus, complete set of oxygen fittings, and emergency oxygen flasks. To decompress or "supercharge" himself, the pilot dons the inhalation apparatus, consisting of a naval face mask, breathing bag, and rubber tube connected to the oxygen cylinder, turns the valve to start the flow of oxygen, and then begins to pedal the bicycle. The pace set is equivalent to walking at the rate of 2½ miles an hour, and is maintained for 30 minutes. To prevent becoming overheated, the pilot exercises in light clothes. From the time he starts breathing oxygen in the decompression room, however, until he has nosed his plane back to lower altitudes, the pilot cannot take a breath of "fresh air." One whiff of air containing nitrogen would undo all his supercharging effort and expose him to the "bends." As a result, the pilot puts on his flying suit in the decompression room, while still "hitched" to the oxygen cylinder. Before leaving to climb into his ship, he switches to a small portable oxygen flask which is carried to the plane, where the pilot connects his inhalation apparatus to the plane's oxygen tanks.

Mr. Burcham was examined before and after these tests, and rapid flights to well above 30,000 feet proved entirely successful. Marshall Headle, chief test pilot for Lockheed, believes that to make the new fighting planes fully effective, decompression rooms should be made available to all combat pilots awaiting the call of duty.

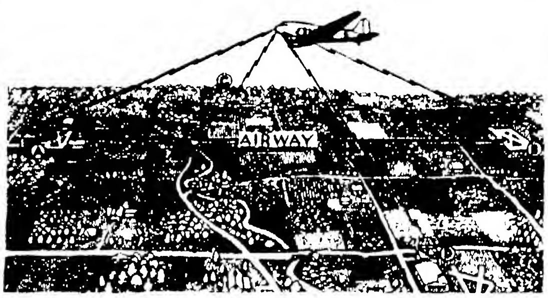
PLANE LOCATION

Triangulation-Plus Spots Transports

A THOROUGHLY practical method of locating the exact position of a transport in the air has been announced by J. R. Cunningham, Director of Communications for United Air Lines. The airplane, equipped with a high-frequency radio transmitter, emits a signal from time to time. On top of a building at the terminal a large metallic frame is rotated by an electric motor. When the antenna is bearing directly on the airplane and receiving a signal of maximum intensity, automatic equipment indicates the bearing of the craft on a map in the dispatcher's office. Given two stations communicating with each other at a known distance apart, and the bearing of the plane from these stations, it is a simple matter to secure the loca-

Adaptability to training purposes, for use in the C.A.A. Flight Training Program, is one of the features of the Taylorcraft Tandem plane shown

tion of the aircraft by drawing two lines on the map and seeing where they intersect. Then the pilot can be told, by phone, where he is if and when he needs such information. The artist's sketch actually indicates four stations at work, one at each end of the airway and two off the airway, but this is merely to provide a check. The experimental tests proved highly successful and standard usage will follow. Our readers will readily grant the utility of this device, which, while not quite new in principle, is efficient and rapid in operation.—*A. K.*



Airplanes can be successfully located while in flight by using the method developed by United Air Lines. The plane's radio transmitter sends out a signal at regular intervals. These signals, picked up by two or more receivers, give data for triangulation on a map

PLANE CONVERSION

Sport Plane Converted to Tandem Military Trainer

WITH the enormous number of young men who are learning to fly under the auspices of the Army Air Corps or the Civil Aeronautics Authority, it is essential to have efficient, modern, training planes at the most reasonable prices possible. The manufacturers of the light planes of today, who have indeed brought prices down and production up, have met the situation splendidly by converting their side-by-side cabin two-seaters into two-place tandem planes, with instructor behind the pilot. Thus Taylorcraft Aviation has brought out a Taylorcraft Tandem, adapted for training purposes. With seat cushions removed there is full provision for seat and back parachute packs. Other interesting features are ball-bearing, self-aligning controls, giving the smooth operation necessary for instruction purposes.

Seats are quickly adjustable to take tall or short students. There is a single exhaust and an efficient muffler. Specifications indicate how our light planes are increasing their performance. With a 65 horsepower Lycoming, Continental, or Franklin engine and a gross weight of 1200 pounds, top speed is 102 miles per hour; cruising speed, 92 miles per hour; service ceiling, 15,000 feet; rate of climb, 600 feet per minute; range, 300 miles; landing speed, only 35 miles per hour. Wing area is 180 square feet; span 35 feet, 5 inches; overall length 22 feet, 9 inches.—*A. K.*

CRASH BLAME?

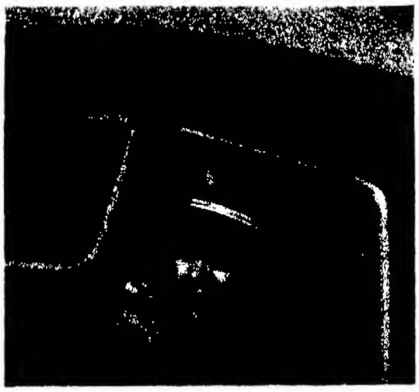
CERTAINLY the regulation of aircraft has been a political football. First we had the Aeronautics Branch of the Department of Commerce; then an independent Civil Aeronautics Authority; and now a Civil Aeronautics Administration back in the Department of Commerce. It would be infinitely better to have the important task of regulating aircraft safety left in one particular bureau, board, or what-not long enough for its functioning to become effective. But, on

the other hand, it is entirely unfair to place all the blame for the recent airline crashes on the Civil Aeronautics Administration as at present constituted. No board in the world, whatever its composition or organization, can guarantee safety; this is a complex problem of regulation, radio, instrumentation, flying and ground personnel, and a thousand and one items.—*A. K.*

TWENTY YEARS AFTER

Aviation Communication Makes Mighty Strides

THE air transport industry, the Post Office Department, and cities along the San Francisco-New York airway recently celebrated the 20th Anniversary of the first transcontinental day-and-night flight of



Captain Jack Knight

1921. Featured in the observance was Captain Jack Knight, of United Air Lines, pilot with 2,400,000 miles to his credit, who covered the entire night portion of the flight from North Platte to Chicago with the aid of farmers' bonfires. What a long way air transport in the United States has moved from those early days, and what magnificent aids to navigation have replaced the rudimentary devices!

Quite recently there have been important developments in aircraft radio communications. Thus, the Civil Aeronautics Authority is installing ultra-high-frequency radio-range stations between Chicago and New York. The ultra-high-frequency range is superior to the low-frequency type now in use because of its fidelity of transmission and freedom from static. Frequencies range from 119,000 to 126,000 kilocycles as compared with the present 200- to 400-kilocycle band. Similar installations will be made on all the nation's airways. To match the new radio ranges, United Air Lines has begun the installation of 100 special radio receivers on its entire fleet of mainliners at a cost of nearly $100,000.

United announces other ambitious undertakings in aircraft radio communications. After months of research and development by the airline and the Federal Telegraph Company, new 5000-watt radio transmitters are being erected, which are described as the most powerful aviation transmitters in the world. Superseding the 400-watt transmitters now in use, they will operate on ten different frequencies, and planes will now be able to hear ground stations under all weather conditions. With the new transmitters, there will be installed on the transport planes new combination receivers and transmitters, also operating on ten frequencies, any of which can be automatically selected by the pilot. Using this light, compact unit, pilots of a plane in flight over Cheyenne were able to talk to ground stations on the Pacific and Atlantic Coasts simultaneously.

A third and highly impressive project of United's communications experts is the construction of a

Control units used in connection with the new radio installations described on this page. Shown also are the special typewriters and record forms used in keeping complete and accurate logs of all voice communication between ground and airplanes

new antenna. It is 1200 feet long, 500 feet wide, and 100 feet high, covering an area of 600,000 square feet. Around each of the four poles of the antenna there is strung a quarter-inch copper-clad steel wire. The new antenna gives a greatly amplified signal because of its directional characteristics. The receiver is absolutely silent, until it is automatically switched on by signals from planes or ground stations. Receiver, transmitter, and antenna are all linked with a communications center where the radio operators are stationed.—*A. K.*

CAMERA ANGLES

Conducted by JACOB DESCHIN, A.R.P.S.

Three-Color Printing Simplified

MORE amateur workers than you can shake a stick at have been scared away from color photography by the bugaboo of lengthy processing and other matters. It is true that such a process as carbro, for example, is rather involved for the average worker, but this should not deter him from making color prints; there are now on the market several color-printing processes that provide a simple routine. One of these is the Chromatone Process, which was described here upon its announcement several years ago. The latest to make its appearance is the Iso-Color Process, which introduces a new idea in color printing, one of the principal advantages of which is that it simplifies the procedure and thereby cuts down the working time to well under an hour.

Iso-Color is a dye-coupling process, similar to the Develochrome monochrome toning method discussed last month. Developing and toning of the three prints required to make up the finished three-color result are done simultaneously, the black silver image being later eliminated by bleaching.

Three separation negatives form the basis of this as of other color-printing methods. These are obtained either directly by exposing three films through three filters in one camera, or by "separating" the colors in a transparency, such as Kodachrome. Several firms have introduced the service of making separations from Kodachrome at nominal prices so that at the start, at least, you need not be concerned about this end of the routine.

The Iso-Color Process calls for nine separate steps. The basic materials are furnished in a kit. Other chemicals, such as hypo, sodium sulphite, and potassium bromide, are presumed to be part of every dark-room worker's normal stock, and acetone is readily obtainable. Besides these, the following materials are required: Chromatone Print Paper (the stripping film); support paper (any smooth, white paper of suitable weight); sheet of plate glass or other hard, flat material for assembling the final print (should be somewhat larger than the print to be made); flat squeegee; gummed paper tape one inch wide; brown bottles, three 4-ounce, two 16-ounce, one gallon.

Figure 1: **Stripping**

Full particulars and the necessary formulas are provided in the instruction booklet packed with the kit, so

Figure 2: **Stripped**

we shall give merely an outline of the process, just to give you an idea of how it is done. We recommend starting out with a set of separation negatives ready-made for you from one of your own Kodachromes. The printing time for the red, yellow, and blue images will vary, but the difference in exposure will also be indicated for you by the makers of your separations.

The key to correct exposure is the negative from which the red image is to be made (the negative that was exposed through the green filter in making the separations). A test print of a section is made as in ordinary black-and-white printing and is developed in the red developer and fixed. After this the worker selects the exposure necessary to turn out a black-and-white print of good quality. This exposure time is used to determine that of the other two negatives, which may be done simply by following the printing ratios indicated for your ready-made separation negatives.

Development is the second step. This takes five minutes at 65 to 70 degrees, Fahrenheit. Each print is developed in its own color developer, one for the red, the second for the yellow, the third for the blue. Since

Figure 3: **Squeegeeing**

all solutions must be discarded after one use, one tray may be used successively for each of the three baths, though it is obvious that three trays, one for each color, would be more convenient. After development, rinse quickly in running water, and fix in the hypo-sodium bisulfite bath for five minutes.

All the foregoing steps are carried out by the light of the Wratten OA safelight. The room lights may now be turned on.

Bleaching is the fifth step. The prints are taken from the hypo, without rinsing, and are placed in the bleach for about two minutes. What happens here is a small miracle. When the exposed print was placed in the color developer it developed a black as well as a color image. After the bleach only the color image remains, the silver image having been bleached away.

The prints now go into the hypo solution, without rinsing, and stay there until the yellow stain disappears. Then comes washing, which takes only two to five minutes in running water.

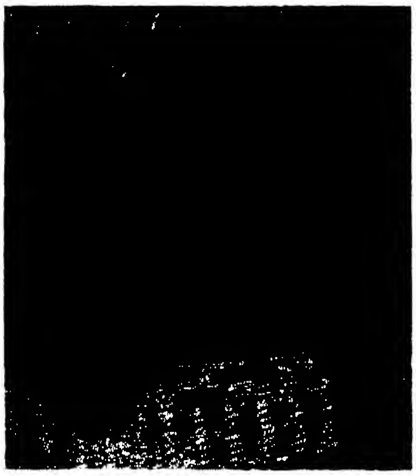
The next step calls for stripping the film away from its paper support. This comes off very easily, and the paper support may be saved to use for the final assembly.

Figure 4: **Taping**

The support paper is soaked in water for about five minutes and then placed gelatin side up on a glass or other flat, waterproof surface. The prints are now assembled by superimposing the red on the yellow print and the blue on the red, all in perfect register, using a squeegee to fix each print firmly in place. The final detail is to tape the print down with one-inch gummed paper tape on all edges. In this condition it dries, and the result is your first three-color print.

Dogs Can Pose

GIVE a dog a comfortable place to sit or lie down and you will have no trouble getting him to pose for you, as did this one, "Black Michael." An easy chair with a soft seat was just the thing on the night we were shooting Michael. We had tried a harder seat before, but no soap; he'd rather have the hard stone floor. Once on the soft seat, however, we could have had him posing for us all night. A



"Black Michael"

1000-watt main source light and a No. 2 Photoflood as an accessory light provided enough illumination for good exposures at $f/4$ and 1/50 of a second.

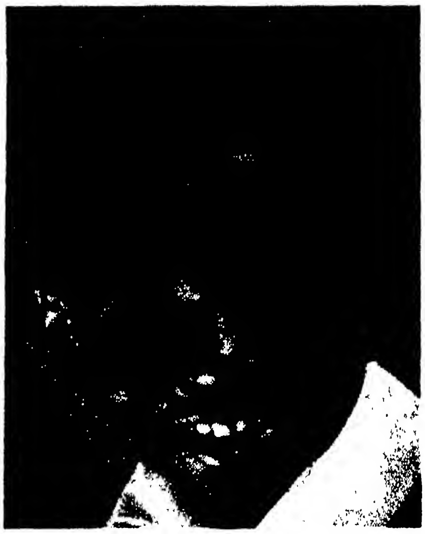
Developing Contrasty Subjects

WHERE the subject photographed is illuminated with very contrasting lighting, normal development usually results in shadows without detail. One worker, confronted with such a problem, hit on the idea of cooling the developer down to about 50 degrees; that is, to a point where the developer is practically inactive. He then placed his film-loaded reel into the tank, closed the top and allowed the film to soak in the developer solution for about 3 to 5 minutes. He next poured off the developer, gave the film a quick rinse, and poured in plain water, where the film remained for about 15 or 20 minutes. The temperature of the water was raised to about 70 degrees. This warmed the developer that had soaked into the film and allowed development at a very slow rate, giving an opportunity for the

shadows to come up without blocking up the highlights. It is important, when attempting this method, not to agitate the tank when filled with water because this may shake off the developer and dilute it too greatly.

Angle the Easel

"THE greatest thrill of my life came when I learned about angling the easel," an enthusiastic professional worker told us recently. He found that in making portraits a sharp turn-



"Ivy"

ing of the easel off vertical gave him an entirely new and lively impression of the subject that appeared static when printed in the usual way. Like other deviations from the straight and narrow path of straight printing, this method must be practised with some caution and considerable exercise of good taste. "Ivy," reproduced here, is an example of moderate easel-angling, enlarged from a negative in which the head was vertical and included about half the boy's figure.

Waxing Prints

TO GIVE prints a sprightlier appearance, a wax rubbing down is often employed. An effective method is to use the following formula: dissolve 800 grains of mastic in a quart of spirits of turpentine; to this add 16 ounces of melted white wax well stirred. Then put this preparation in a warmed jar and when it has cooled apply it with a flannel to the print, rubbing well. When you have finished, you may observe a few streaks due to uneven application of the wax. By warming the print for a few minutes, the streaks will disappear.

1 and 2, not 1 to 2

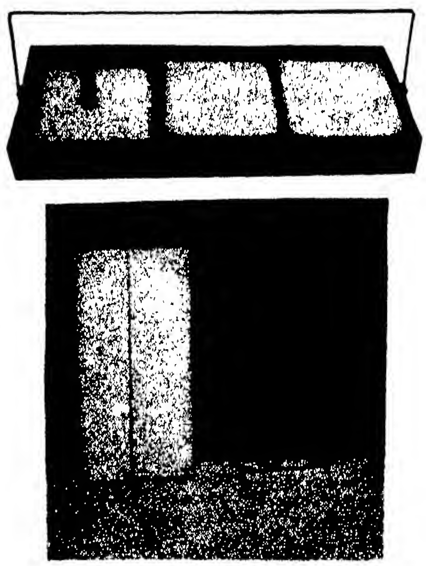
RECENTLY we were called to task for using the term, "one to two" when indicating that a certain stock solution was to be diluted one part stock to two parts water. The gentleman in question was a chemist, who explained that, in chemist's language, such numbers refer to volume and that when a chemist states "one to two" what he means is that one part of solution is to be increased to a total volume of two by the addition of one more part of water. In stating the matter the way he does, he says, the photographer calls for only one part of water to one part of stock solution when what he actually means is two parts of water to one part stock.

We explained to the chemist that this phrase has been well understood by photographers from 'way back as a short way of saying "one part of stock solution to two parts of water," and that if a phrase is understood, even though it may not be exactly correct, that is all one expects. In chemist's language, by the way, the term is "one and two," which means one part stock and two parts water. That this makes the matter more clear, is our chemist's argument, and maybe he's right.

Temperature-Controlling Tray

DEVELOPERS for printing papers such as Azo or Kodabrom give best results when the solution is between 65 and 70 degrees, Fahrenheit, with varying and unsatisfactory results when the temperature is below and above this standard.

Keeping the solution at the required temperature can be easily accomplished (in summer) by constructing a special metal tray of galvanized iron, in which the usual processing trays



Top: **Temperature-controlling darkroom tray.** *Lower:* **The tray, and tubing that carries water**

are placed. Soldered to the inside of the bottom of the galvanized iron tray is a grid made by bending a length of one-quarter inch copper tubing, the open ends of which project through holes drilled in one side of the tray. One end of the spiral tube connects with a flexible rubber tube to the cold water faucet; the other end, through a similar piece of the tubing, goes to the basin drain.

The idea is to allow cold water from

the kitchen faucet to spiral its way through the copper grid in the bottom of the large metal tray and empty out as described; in so doing, it will have a cooling effect on a metal photographic trays resting on top of the copper grid tubing. If three metal photo trays (they can be stainless steel or enamel) are placed on the grid, then all three will be at the same temperature, which is what is wanted in developing prints. Blisters and stain occur when a print is changed from a cold developer to a warm stop bath and finally to an even warmer hypo fixing bath.

The sides of the temperature-controlling tray should extend upward about an inch higher than the sides of the photo-trays. The large tray can also be fitted with a bail handle bent up from one-quarter inch steel rod. Before soldering the galvanized tray joints at the corners, the solder will work better if the places to be soldered are first brushed with a solution of 28-percent acetic acid (same as used for stop-bath purposes) and the soldering accomplished over this in the usual manner; Geko solder can also be used to make the work easier. After the soldering has been finished, which includes soldering the copper tubing to the bottom and in the holes of the tray, clean up the whole assembly with a wire brush and scouring powder, then paint everything, inside and out, with Kodacoat acid-proof black paint, which dries in about 15 minutes.

—*Herbert E. Hayden.*

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WHAT'S NEW

In Photographic Equipment

Victor Midgetflash No. 64 ($1): Adapter-reflector to convert medium base receptacles for most effective use of midget lamps. Unit has 4½-inch parabolic, polished aluminum reflector clipped to plain bayonet socket Edison base adapter.

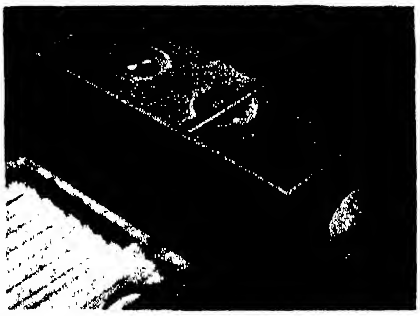
Kodak Farmer's Reducer (75 cents for carton of five tubes): Each tube makes 16 ounces of working solution. Farmer's Reducer is two-solution corrective reducer designed for correction of over-exposed and over-developed negatives, and for limited print reduction.

Princeton Combination Sunshade and Filter Holder (75 cents): Adapter ring of screw-type replaced by new adapter ring of semi-flexible rubber. Will cover all lens barrels 24mm to 42mm. Available sizes: four adapter rings to be used with 29mm sunshade; two with 39mm sunshade; two with 42mm sunshade; one with 45mm sunshade.

Incre-Light 2½-inch $f/1.65$ and four-inch $f/2.5$ Bell and Howell Projection Lenses ($30, $17.50): $f/1.65$ lens 40 percent faster than $f/1.9$, especially adapted to take advantage of violet and ultra-violet end of spectrum available in arc-generated light of Filmoarc. Equally efficient mounted on any Filmo projector. Four-inch $f/2.5$ replaces $f/2.8$ model, giving 25 percent greater brilliance.

Albert and Royal Midget Tripods ($3.50 and $1.95): Both designed for short range work. Albert is constructed strong enough to hold heavy cameras; has long-handled tilt-top that locks securely in any desired position and holds cameras at all levels from table top to 13 inches. Royal Midget similar in design except for tilt top, which is simplified.

Vuescope Color Viewer ($3.95): Compact, lightweight rectangular steel box, about 2⅛ inches square, 6¼ inches long. One end of Vuescope equipped with large, clear viewing lens. Two and one-half inches behind lens is slot for insertion of 2 by 2 inch color slides. Remaining space in



box occupied by two small dry cells, small bulb, ground glass diffuser, and switch. Slide appears large as 5 by 7 inches. Slot accommodates all popular 2 by 2-inch slides. Equipped with spring tension clips to keep slides from falling out.

Photo-Compact Combination Enlarger, Printer, and Safelight ($34.50): Designed for use with all cameras from 35mm to 3¼ by 4¼ inches. By attaching ordinary camera to Photo-Compact, user has complete enlarger with built-in dodger and combination safelight switch. By attaching platen and masks supplied, Photo-Compact can be converted into contact printer.

Kemp Tray Thermometer (35 cents, three for $1): Entirely encased in white rubber, making it shock-proof, acid resistant, and non-corrosive. Designed for tray use by immersion in solution. Legible in darkroom as figures on rubber sheath are highly embossed and darkroom lamp throws distinct shadow of figures and gradations.

Royal Tripod, 1941 Model: Features new plastic cap on head. "Quick-Lock" leg adjustment improved with new leg locking nut. Tilt head now provided with adjustable camera screw which can be lengthened or shortened to accommodate camera screw sockets of various lengths.

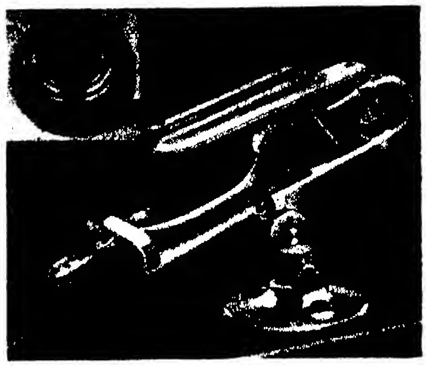
YOUR FIREARMS and FISHING TACKLE

Conducted by A. D. RATHBONE, IV

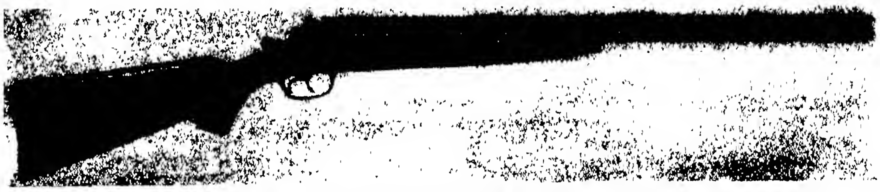
INTEREST IN FIREARMS *is traditional with American men; fishing tackle is a requisite of one of the world's oldest occupations. Scientific development of guns and tackle, in the use of which millions yearly find sport and recreation, fathers this monthly department which welcomes correspondence from readers.*

Wing-Shooting Practice

If there is one goal toward which we average shotgunners aim, it is reasonable proficiency in wing-shooting. Not many of us go afield more than six times during bird season and the total number of shells fired at flying targets can't be regarded as wing-shooting practice. Then, likely as not, we put the gun away until next season. True, many of us hunt crows, shoot skeet or trap, thereby keeping eyes, muscles, and hand in training, and despite all arguments that none of these truly approximates grouse or pheasant shooting, the more frequent the use of the shotgun on moving targets, the more the gunner will have confidence, assurance, and familiarity with distances and target leads. In other words, trite though it may be, practice still tends toward perfection.



Hand operated "Skeeter Trap"



Stevens, model 240, .410 bore, over/under. Ideal for "Skeeter Trap"

Two difficulties that have long faced the bird hunter who desires to practice are a place to shoot and, regretably, the matter of expense. Justifiably popular as skeet shooting has become, skeet fields are still too infrequent throughout the nation to accommodate our army of shotgun users. Moreover, not all of us can afford to belong to clubs or associations, and as the crows can't always be depended on to be present when we desire shooting practice, many of us shrug our shoulders resignedly and let the matter drop.

Shooter's foot releases trap

Not long ago, however, we found a solution to this problem. It has materially helped to improve our shooting, it has cost us very little money, and it has the distinct advantage of portable equipment. In a few minutes we can set up our "Skeeter Trap" in a convenient field. Using our little .410 bore over/under Stevens shotgun, we can burn up four boxes of shells blasting away to our heart's content at miniature clay targets, in singles or doubles, thrown from our "Skeeter Trap," and we've had a couple of hours good fun and practice. The cost? The trap is either $14 or $15, depending on the model, and that is our permanent investment, good for years to come. The miniature clay targets run about a half-cent each, and shells for the .410 shotgun range from 50 cents upward for the 2½ inch length in case lots.

As we said, the "Skeeter Trap" will throw singles or doubles, and, as illustrated, the shooter may release his own targets by foot pressure, or the trap may be sprung by a cord in the hands of a companion. The "Skeeter Trap" will throw any of the little 2⅝-inch clay birds a distance

of 70 to 80 feet, so it requires snappy action to score doubles. It isn't, of course, necessary to use a .410, but we specified that size shell because of its low cost. Larger sizes are entirely acceptable, and you can, if you like, be very sporting and use a .22-caliber smooth bore gun with the .22 long-rifle scatter-shot shell. However, as we are trying to approximate hunting conditions as closely as possible, we suggest the .410 as being the nearest approach to sporting conditions and, at the same time, the least expensive in the shotgun class.

There are also several possible variations to "Skeeter Trap" shooting. The trap, or traps, can be arranged in the proper terrain to simulate quail shooting, a brush walk, a grouse range, or a covey rise, in all of which the "birds" take off with startling suddeness from unexpected places to offer extremely sporting shots and splendid practice. We have folders on the "Skeeter Trap" which detail all these ideas and more, provide suggestions for your spring and summer shooting practice, and they're free.

What About the Striper?

SHALL the striped bass of the eastern coastal waters legally be made a game fish (as is the imported striper of the West Coast), or shall we go along as we are today, letting the commercial fisherman decimate the ranks of this "gentleman of the surf"? From Massachusetts to Virginia this is a question that is being heatedly argued by all those who have the least interest in salt water fishing in general, and in surf fishing in particular.

Only some forty years ago, striped bass on the East Coast were present in such numbers that commercial fishermen would take tons of them in a single haul of a net. Today a commercial boat is lucky if it can account for as many stripers in a whole season. And the situation is even worse for the surfman. He has seen one of the finest game fish of the surf gradually disappear from its former haunts, decreasing in numbers to a point where the surfman is lucky if a dozen days and nights on the beach yield even one striper.

What is to be done about it? Make the striper a game fish, removing it from the list of fish that can legally be taken by commercial fishing methods, is one answer, and probably the only logical one. This would preserve *Roccus lineatus* for future generations; at the same time it would work no hardship on the commercial fishermen who, today, would starve if they had to depend entirely on the striper for their livelihood.

"Gentleman of the surf"

There is definite foundation for the belief that making the striper a game fish would have beneficial results. Experience on the West Coast proves the point. There the striper was introduced from eastern waters and completely protected. Today the striper on the West Coast furnishes sport for a vast number of surfmen and other salt-water anglers.

It is still not too late to build for a similar future on the East Coast. Maine and Louisiana have passed laws that make it legal to take stripers only by rod and line. But the other states on the eastern seaboard must do the same before results can be obtained. There is only one way in which this can be accomplished. Interested sportsmen must get up on their hind legs and holler—holler long and loudly, individually and collectively, until the furore is heard in the legislative halls and a realization is reached by the powers-that-be that this is the voice of a majority that must be obeyed.—*A.P.P.*

Defense and Sporting Arms

IT ISN'T news that national defense requirements are demanding practically the full facilities of American manufacturers of sporting arms, but perhaps it is news that military necessities in small arms are not the only defense reason for the bustling production lines. The military requirements come first, of course, but we still have the needs of civil officers, who must be armed, and now there is a third group that has to be considered. It is composed of armed guards and plant police for the industries producing defense materials. This latter group is a large one that has sprung up almost over night, for under normal circumstances such guards are not armed. After the needs of all these are cared for, come the sportsmen.

Worth waiting for: K-22

This is an unfortunate situation, because with war no longer being confined to well-drawn battle lines, there was never, in our opinion, a time when the training of civilians in the art of shooting was quite so important as now. Certainly, in the recent tragic history of European countries, it has been proved that a well armed and well trained citizenry is a powerful asset. There is little that can be

done about the situation at the moment, but rest assured that in the hurly-burly of defense the small arms makers have not forgotten their sportsmen friends. At every opportunity sporting rifles, shotguns, and target pistols are shoved through the crowded production lines.

Not long ago we visited Cy Bassett, of Smith & Wesson, who explained some of the present-day trials and tribulations of a concern normally busy manufacturing revolvers for peace officers and target pistols for range shooting. Smith & Wesson, you'll recall, brought out that smart, new .22-caliber revolver, the K-22 Masterpiece, just a year ago. Since then, wartime work has occupied every hour at the Smith & Wesson plant with the result that the K-22's were woefully side-tracked. However, Bassett explained, every now and then there is a minor hitch in production of guns demanded for the military, the peace officers, the special plant police. When that happens, jigs and dies are quickly changed and a batch of K-22's moves on toward completion until the hitch in defense gun manufacture has been eliminated, after which the K-22's are again necessarily shoved aside. By such heroic efforts are Smith & Wesson and other makers of sporting arms desperately endeavoring to care for the desires of their sportsmen customers.

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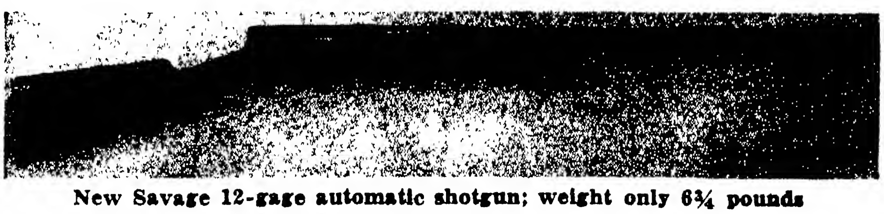
POT-SHOTS

At Things New

Savage Arms Corporation has ended the long search by upland game hunters for a light weight *automatic* shotgun by producing a new 12-gage automatic weighing about 6¾ pounds. In this newest of Savage shotguns, Model 745, ready for delivery May 1st, the use of Alcon, an astonishingly light but tough metal, in constructing



New Savage 12-gage automatic shotgun; weight only 6¾ pounds

the receiver of the gun decreases its weight by a full pound. This means that now, for the first time, hunters may own a 12-gage automatic, hammerless, takedown shotgun that is about as light and easy to handle as many 20-gage guns. Model 745 has a plain, round barrel of special alloy steel, 28 inches long. It is chambered for 2¾ inch shells, with improved cylinder, modified, or full choke boring. Stock and fore-end are of selected walnut, checkered. Stock has full pistol grip, is 14 inches in length, has drop at heel of 2¾ inches, and is equipped with hard-rubber butt plate. Breech is solid; top of receiver is matted; there is a friction ring adjustment for light and heavy loads; a cross bolt safety at rear of trigger guard, and a three-shot magazine plug is furnished at no extra cost. We have Savage, Fox, and Stevens catalogs. Want one?

Bill DeWitt Baits, makers of fly boxes, lures, and many other fishing necessities, and who last year introduced absolutely rust-proof hooks of "Z" Nickel to salt water fishermen, have again earned the praise of the

"Z" Nickel gaff won't corrode

ocean angling fraternity, this time by announcing a Bill DeWitt gaff hook of "Z" Nickel with steel-like strength and which, because of the rust-inhibiting properties of "Z" Nickel, should be good for unlimited service. Due to corrosion by salt water, ordinary steel gaff hooks have relatively short lives, must frequently be cleaned and oiled for preservation, are often replaced several times before the handle wears out. Through use of "Z" Nickel it is expected the hook will outlast several handles and cleaning will be unnecessary because of properties of the metal.

Bevin-Wilcox Line Company's catalog depicts trout lines of Nylon or enameled silk; double water-proofed silk casting lines for all manner of fresh water work; an unsurpassed Cuttyhunk selection. Also phosphor bronze leaders and a splendid article on "The Use and Care of Fishing Lines." Want a copy?

Richardson Rod & Reel Company's 1941 catalog presents a complete line of seamless tubular and solid steel bait casting, trolling, and fly rods with strength, flexibility and balance more than adequate to meet the most gruelling challenge of "fightingest" fish. We'll send you one, free.

"Hysterical Legislation," an editorial on page 259 of this issue, has to do with proposed laws requiring registration of privately owned firearms and is a matter of importance to every American gun owner.

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with a list of available titles, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for.

FLIGHT
"First Principles"
"Construction and Maintenance"
By Wright, Smiley, and Martin and a staff of aviation experts.

HERE are two comprehensive volumes that are grouped in one review because of the manner in which they complement each other. In the first volume—"First Principles"—the reader is lead through aerial transportation from the very beginning to modern practice. In comprehensive text, accompanied by excellent photographs and drawings, are covered the fundamentals of aerodynamics and their applications in both powered and soaring flight.

In the second volume—"Construction and Maintenance"—stress is laid upon manufacture and repair. Here again a large number of illustrations serve to make the text more complete.

Quiz questions at the end of each book enable the reader to check up on the completeness with which he absorbed the text material. ("First Principles," 283 pages, 6¼ by 9½ inches. "Construction and Maintenance," 259 pages, same size.)—Each volume $2.60 postpaid.—*A. P. P.*

SCIENCE PICTURE PARADE
By Watson Davis, Director of Science Service

SOME 300 selected photographs pertaining to every corner of science, with brief, pointed comment on each, also with short, pertinent chapters. Easy but informative reading—a suitable book for the library table or the waiting room or for one evening of solid enjoyment. (327 pages, 6½ by 9½ inches, 302 illustrations.)—$3.10 postpaid.—*A. G. I.*

HORIZONS UNLIMITED
By S. Paul Johnston

AS RESEARCH Co-ordinator for the National Advisory Committee on Aeronautics, this author combines profound technical knowledge of aviation with a flair for interesting and popular presentation, and the ability to select and emphasize the great historical events of aeronautical development. The book, which is in no sense a formal history, will give to anyone at all interested in aeronautics a graphic and clear picture of the development of every type of aircraft, including airships, lighter than air machines, helicopters, gyroplanes, and airplanes. Moreover, it will explain to the uninitiated the principles involved in each development. Excellent photographs and sketches carry educational value. (354 pages, many fine illustrations.)—$3.85 postpaid.—*A. K.*

A FIELD GUIDE TO THE BIRDS
By Roger Tory Peterson

PRESENTING a new, practical plan for outdoor identification of all species of North American birds regularly found east of the Rocky Mountains, this volume recognizes that color values, rather than the actual colors, are most important in identifying birds at a distance. To this end, diagrammatic drawings of birds are presented in conjunction with descriptions of marks that can be recognized in the field. (180 pages, 4¼ by 7¼ inches, 36 diagrammatic identification plates, 4 color plates, 26 line drawings.)—$2.85 postpaid.—*A. D. R., IV.*

HANDBOOK OF COLOR PHOTOGRAPHY
Edited by Jack Hevesh

WITH the implication that color photography is not difficult and that any worker already familiar with ordinary black and white routine may well enter the field with confidence in ultimate success, this Handbook comes at a time when this appeal should bring a strong response. Edited and largely written by Mr. Hevesh, the book presents, in simplest terms, all of the facts required by the amateur worker to start him off on the right foot in the fascinating field of color picture-making. (116 pages, 5½ by 8½ inches, illustrated.)—$1.10 postpaid.—*J. D.*

FIRE FROM THE AIR
By J. Enrique Zanetti

HERE are pertinent facts regarding the incendiary bombs which are being showered on England. In concise yet relatively complete text, the author deals with early types of these bombs, the modern types, the materials that are used in them, the strategy and tactics around which re-

The Editors Recommend

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A MARRIAGE MANUAL—*By Hannah M. Stone, M.D., and Abraham Stone, M.D.* A practical guide to sex and marriage, covering fitness for marriage, mechanism of reproduction, prevention of conception, and similar vital subjects. Answers questions most often asked these authors by their consultants. **$2.60**

PERSPECTIVE MADE EASY—*By Ernest R. Norling.* For draftsmen and artists, this volume tells the things they should know but often don't— all the details of perspective, simply explained and illustrated so that all rules may be easily grasped, progressively, from simple to complicated forms. **$1.85**

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In U. S. A. **$1.50**
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By Arnold Gesell, M.D.

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tional character, American vaudeville. The author, feature writer and former drama critic of the New York *World Telegram*, spent years interviewing the greats and once-greats, poring over old magazines, prowling around newspaper morgues. The result is an authentic document, rollicking in anecdote, racy in style, and revealing as to history. (428 pages, 6 by 9 inches, 35 illustrations.)—$3.60 postpaid.—*A. D. R., IV.*

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By K. B. McEachron in collaboration with Kenneth G. Patrick

EXTRACT from the mind of General Electric's artificial and natural lightning expert that part of his knowledge of this subject which will interest, but not bore, or swamp the average reader having scientific leanings, and you have this informative, but readable and entertaining book. Facts about lightning; analyzing natural lightning with the moving lens camera and oscillograph; antics of lightning on transmission lines and on high buildings (experiments on the Empire State Building); science in lightning rods, which reduce house risk to 5 percent and are by no means relics of a by-gone day; personal risks from lightning, some old-fashioned ideas being not so crazy after all—this is the scope of the book. (231 pages, 6 x 8½ inches, 16 illustrations.) $2.60 postpaid.—*A. G. I.*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

To make your own telescope, a lathe isn't necessary; a mounting can be devised from parts picked up here and there and adapted. Yet if you do own a lathe you can have a really neat telescope—provided you also were born with a feeling for clean design. John Marshall, of Philadelphia, has such a feeling, as the 4", $f/8$ reflecting telescope shown with him in Figure 1 clearly proves. His friend, L. F. Wiler, 2502 South 75th Street, also of Philadelphia, sends in the following description of the telescope.

"The tube is made from 16-gage sheet metal and turns in supporting rings, so that the eyepiece is always in the most comfortable position. Originally, the mirror was mounted in a wooden cell, but the wood shrank, causing a pronounced astigmatic image, so a new brass cell was made.

"The polar and declination axes are of 1⅝-inch cold-rolled steel tubing turned true, and ground into the four bearings. These were cut from scrap bronze, bored to fit the tubing. Turning friction can be adjusted by tightening the capscrews on the split side of the bearings. Thrust is taken up by steel collars on the axes. An adjustment atop the hollow tripod allows an azimuth change to be made without moving the legs around.

"The legs are 2½-inch bar channel, bolted to the base. They have leveling screws at the bottom. This seemed to be the most logical way of supporting the instrument, since it is used in the city, standing on concrete walks.

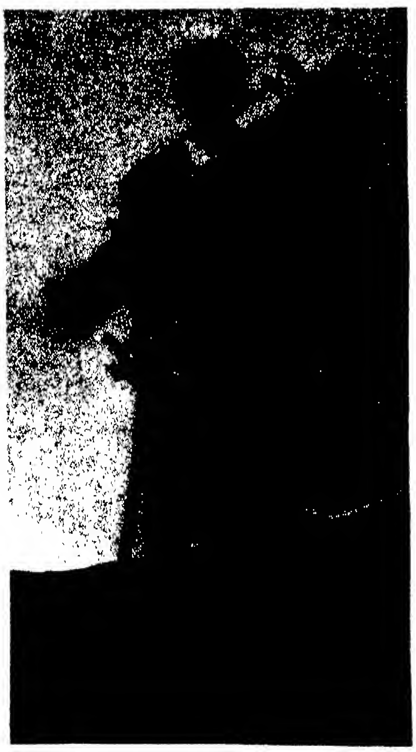

Figure 1: **Marshall and reflector**

"Motions in right ascension and declination are made by two slow-motion thumbscrews. The worm and worm-gear ratio is about 20 to 1. Worms and worm gears also were made by Mr. Marshall. The thin, split extensions of the hubs of the worm gears are tapered and threaded on the outside. The worm gears are locked in position on the axes by turning up the threaded collars on these extensions. Quick adjustment through large arcs can be made when the collars are turned back. The axes then turn freely in the bores of the worm gears.

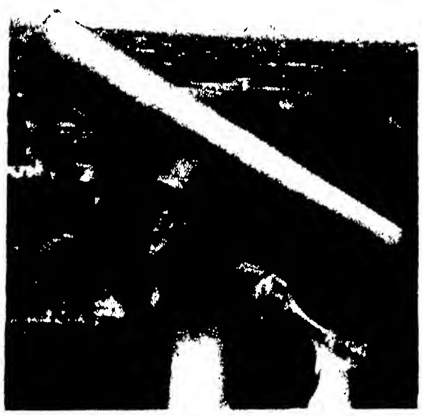

Figure 2: **Hough's 16" telescope**

"The telescope is further glorified with two circles graduated in degrees. The finder was made from a piece of brass tubing. Its optical system is from the lenses of an old box camera. It serves the purpose well, in spite of the chromatic aberration.

"The total cost of material, including the prism and aluminizing the mirror, was $5.75. The man-hours that went into this telescope are astronomical."

If you are flirting with the idea of building a telescope, and have been reading this department of the magazine for months or years, as we know many do before actually making the pick-up, do not be frightened off by the large size of some of the instruments described here from time to time, since these are not first telescopes. Most amateurs start with a 6" size, make an 8", perhaps a 10" or a 12½", and by that time have gained enough experience to tackle something larger, if they wish to go that far. Unusual—probably unique—is the 16" reflector of Springfield type (Figure 2) described below, made by a user of the handbook, "Amateur Telescope Making," C. W. Hough, Box 145, Route 1, Pasadena, California. Actually this is three telescopes on one mounting, the "other two" being 3" refractors mounted beneath the tube of the main reflector. By moving a simple slide the same eyepiece may instantly be applied to any one of the three. Hough writes:

"The 16" mirror for the reflecting telescope was ground and polished by hand on an HCF lap. Its short focus —48", or $f/3$—required the removal of about 1/3" of glass at the center of the curve. [When asked why he chose this great focal ratio, instead of the more usual $f/8$, Hough replied that he was attracted by the difficulties promised in "ATM" in hand-working a mirror larger than 12" in diameter, and in figuring one of great focal ratio; he also wanted large light-gathering power.—*Ed.*]

"The equatorial mounting was made from an old Dodge rear axle and drive shaft. On the upper end of that axle is mounted a wheel hub and brake drum, and to this unit is bolted a forged yoke which supports a 200-pound lead counterweight.

"Sliding around the outside of the drum is a setting circle, which may be clamped wherever desired for settings in right ascension.

"On the brake drum on the end of the sloping polar axis shaft and bolted to it at right angles, is the end of the propeller shaft housing from the same old Dodge car. This unit consists of the housing, ball-bearing cage, and drive shaft. This drive shaft was bored out and serves as the light-channel from the diagonal to the prism beneath the eyepiece.

Figure 3: **Hough, close-up**

"The second wheel hub is mounted on this drive shaft, and on the hub part is mounted a second brake drum through a plate friction clutch. This is driven in slow motion by a worm and right and left hand-wheels. A similar friction clutch is built inside the first or polar axis brake drum, and, like the other, is turned in slow motion by double hand-wheels, or else may be driven by an electric motor back-geared to the handwheel shaft (Figure 3). The declination circle is screwed to the flat face of the second brake drum and is dimly lighted by a 6-volt lamp, the hour circle being similarly lighted.

"The main tube is 17" in diameter and 100" long, hence the telescope's pet name, 'The "100-inch-Long".' The tube's four internal stiffening rings were made by spinning a 19" diameter steel plate, turning the edge at right angles and cutting out the center.

"Between the tube and brake drum is a short stub, or T, of metal tubing welded to the tube, and through holes in this stub piece two 3" refracting telescopes, pointing in opposite directions, one an $f/12$, the other an $f/18$, are inserted, their outer ends bolted to the big tube.

Figure 4: **Hough, back side**

"The 1" diagonal prism for the 16" reflector is mounted on an adjustable unit attached to the side of the big tube.

"The mirror rests in a spun steel cell on felt pads and has the usual three adjustments, plus radial adjustments.

"Inside the T stub mentioned above is a brass slide parallel with the three telescopes, and on it are mounted two prisms, also a 1" achromatic negative lens in the center. Handles (Figure 3) for sliding this slide project through the T, a detent holding the slide in the selected position. The prisms and slides are mounted on micrometer adjustments and the three telescopes are adjusted for identical focus and center at infinity. The 1" negative, achromatic Barlow lens mentioned above is 11" from the main diagonal, and focuses 15" farther along at the eyepiece, the cone of rays first passing through the ½" hole in the declination axis and being reflected by the second prism below

the eyepiece. The eyepiece mounting is fixed in position.

"The telescope may be swung by hand by slight pressure, against friction of the clutches. Fine adjustments then are made by means of the handwheels. The drive motor is thrown in gear by a milled screw seen silhouetted above the lower handwheel in Figure 3. Motor speed is controlled by a variable resistance. While not synchronous, it keeps a star in the field of the 16" mirror for an hour or more without adjustment.

"I live on a hill overlooking Pasadena and Altadena, and with Mt. Wilson in the northeast, and I use the 3" *f*/12 as a terrestrial unit, then reverse the telescope and use the refractor and reflector interchangeably, without leaving my seat or taking my eye from the eyepiece. I believe this assembly of three different telescopes on one universal mounting, with a single, stationary eyepiece, is a new idea.

"The telescope is waterproof, the large tube having a spun cover seen hanging on the southern pier in Figure 2.

"Figure 4 shows the rear, with transformer in center, motor rheostat at right, motor holding clamp at left, polar axis clutch in center, and the worm screw rings shown in part.

"All the auxiliary equipment is mounted on the original brake band support. The foundation bolts are the ½" U-bolts once used for bolting the rear axle to the springs of the Dodge car. Two of these were fitted with washers and nuts and placed nuts down, one in each of the two foundation forms parallel with the axle. The other two were interlaced with the first two, with the threaded ends projecting through the form to straddle the car axle. The latter bolts were wound with clothesline, over which was wound two layers of rubber tape. Concrete was then poured and, after it was thoroughly set, the clothesline and tape were pulled out. This provided about ¾" space for movement of the bolts for polar adjustment.

"Originally I mounted the 200-pound lead counterweight on an arm at the lower end of the polar axis shaft, but the torsion twisted the 1⅛" shaft so much that the unit was out of balance in both east and west directions, and this is the reason for the rather heavy forged yoke which now supports the counterweight. The telescope is now perfectly balanced in all directions and extremely rigid.

"On top of the main tube, and in line with the declination axis, is an 8" by 8" manhole which gives access to the prism, and this hole normally is covered by a curved plate. My camera is attached to an identical plate which fits on the same projecting studs. This plate mounts a prism positioned in the axis of the mirror but between the mirror and main prism. Thus the two prisms do not interfere with one another. The light is turned upward, through a high-grade shutter with remote control. When making photographs, the telescope is guided by the refractor.

"I did not do any of the small optical work. Some years ago I picked up from a Third Avenue, New York, junk dealer a large assortment of lenses and eyepieces; two 3" fixed position theodolites; a 2" Throughton and Simms repeating theodolite with 12" scales, a beautiful instrument; World War I trench periscopes. The dealer had bought this for the brass! This material has been very useful. I think it came from some of the early Coast and Geodetic Survey stations. The telescope is largely made up of junk and odds and ends."

NEAT little gadget for mounting a diagonal in a Newtonian reflector is shown in Figure 5, which is self-explanatory (*"Hua-i neng ta ch'ien yen,"* or, picture's meaning can express a thousand words, in case your Chinese has become rusty). Developed by Max Burgdorf, Natchitoches, Louisiana, and made by Lorane Brittain and Sherwood Burgdorf, it takes the place of the more customary

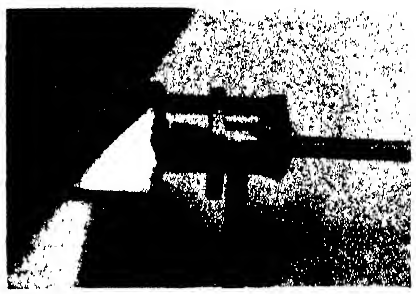

Figure 5: **B, B and B support**

spider support for diagonals and would cause a less complicated diffraction pattern than the latter. They embodied it in their 8" reflector.

The trio, the first-named an ice manufacturer, the second an associate professor of music (teacher of counterpoint and composition) at the Louisiana State Normal College, experienced an amusing variation on the old theme supplied by professional looking-glass silverers (not telescope mirror silverers) in which they stubbornly silver the back of the mirror disk unless kept under duress; *their* silverer silvered the face, just as requested—and then smeared on a coat of paint to protect it!

SOCIAL item: Annual report of the Director of Mt. Wilson Observatory says the 72" spherical *f*/2.5 mirror for the 48" Schmidt telescope on Palomar Mountain has been figured at the Observatory optical shop; the entire work of grinding and polishing having been completed by Hendrix and Dietz in 21 weeks. Dietz, only a few years ago, was a beginner, reading the present department and starting in by making the orthodox 6" reflector, following the directions in "ATM." Now he is a professional with

his name bracketed with that of D. O. Hendrix, Mt. Wilson's head optician. Home-town boy makes good.

MEDAL — the Coffin Foundation award—has been handed by the General Electric Company to A. W. Everest, Pittsfield, Massachusetts, employee, for his research in the measurement of steel when magnetized. Everest, with his usual modesty, won't tell exactly what he did but we hear he developed a thing actually called a magnetostrictoscope. Not to be outdone by a mere $300,000,000 corporation, your scribe, on August second, at next summer's convention of amateur telescopticians in Vermont, will hand to the same Wally Everest a much larger medal, for his research on a close technic in working optical surfaces on glass, and for developing a thing called, with much greater economy of syllables, the "spit test" for radius of curvature.

NO SECOND *edition* of "ATMA" has been published or is contemplated, but whenever a *printing* of the existing edition, which is the first, runs out we try to correct those errors which our readers have kindly pointed out to us. In the second printing, made August 20, 1939, the following errors were corrected and owners of "ATMA" may change their copies as follows:

Page 71, Fig. 2: Cross off top lettering, which is reversed (and unessential).

Page 131, line 7: Delete from "assumed" to end of paragraph and substitute: "Plane mirrors used in the testing of paraboloids and of completed telescopes at their foci must be of high quality as regards smoothness of figure (± 0.1 wave maximum), but uniform sphericity of the order of ± 1 to 10 waves can be tolerated, depending upon the application."

Page 201, line 4 of legend under Fig. 6, for first nine words substitute "print. The bottom cylinder is cast solid."

Page 227, near top, change 16620 to 1662.0.

Page 348, line 11, change "remaining" to "ramming."

Page 404, line 5, change 2.8 to 3.2.

Page 633, footnote, third line from bottom, delete decimal points.

Page 635, last paragraph, change each *M* to *m*.

Page 637, line 2, change *M* to *m*; line 3, delete *m*.

Those who purchased "ATMA" between August 20, 1939 and February 1941 (third printing) need change only the following:

Page 253, fifth line above bottom, 16 to 15.

Page 266, in Fig. 5, lower, right-hand part, r_1, r_2, r_3 to r_7, r_8, r_9.

Page 404, first line below cut, half to quarter.

In addition to these errors of fact, a number of slips in diction were found and many of them corrected. What real errors have you fourd?

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

HERE'S A PROBLEM YOU SHOULD LICK is a 12-page illustrated booklet that gives reasons why costly dust conditions in an industrial plant should be controlled, and how this control can be brought about by the proper installation of dust collecting equipment. *American Foundry Equipment Company, Mishawaka, Indiana.—Gratis.*

NEW TERMITOPHILOUS DIPTERA FROM THE NEOTROPICS, by Charles H. Seevers, concerns the subfamily Metopinae of the Phoridae, and describes the new species Syntermorphora microphthalma, Crytophora colombiae, Ecitomvia termitoxena, Holalophora gutiquiae, Homalophora metae, and Puliciphora termitophila. *Field Museum of Natural History, Chicago, Illinois.—15 cents.*

KODAK DATA BOOK — SLIDES AND TRANSPARENCIES, the latest Kodak Data Book, contains extensive information on making of Kodachrome as well as black-and-white slides. Included are recommendations on making Kodaslides, methods of printing films and plates, developing technique, information on tinting, toning, finishing slides, masking and binding, storage and projection. *Eastman Kodak Company, Rochester, New York.—25 cents.*

HYCAR is an eight-page illustrated booklet that tells the story of the new Hycar group of synthetic rubbers. The book is written in non-technical language. *Hydrocarbon Chemical and Rubber Company, 335 S. Main Street, Akron, Ohio.—Gratis.*

ELECTRIC MOTORS FOR THE FARM is a bulletin prepared by Engineers of the Bureau of Agricultural Chemistry and Engineering. It presents facts about the types of motors, purposes of various sizes, installing and connecting them, and their care. These fundamentals are essential to the farmer who would become well informed on this mechanical contrivance that can be of great assistance in farm operations. Request F. B. 1858. *Office of Information, U. S. Dept. of Agriculture, Washington, D. C.—Gratis.*

FACTS YOU SHOULD KNOW ABOUT COSMETICS is a 16-page booklet that deals with the whole range of cosmetics from powders to reducing creams, from acne treatments to X-ray machines. It points out that while the cosmetic industry in general is a legitimate one, there are some unethical operators who may even employ poisonous and dangerous substances in their products. This booklet sounds warnings where warnings are needed. *National Better Business Bureau, Chrysler Bldg., New York City.—Three cents.*

INDUSTRIAL RESEARCH INSTITUTE is a 15-page booklet which outlines the nature of this organization, the need for it, its working methods, its value, and membership requirements. Details of this institute will be of interest to all those concerned with industrial research. *Industrial Research Institute, 8 South Michigan Avenue, Chicago, Illinois.—Gratis.*

ESSOLUBE HD is a 16-page fully illustrated pamphlet which gives a complete description of the properties of this high-viscosity detergent type of oil for heavy-duty gasoline and diesel engines. *Standard Oil Company of New Jersey, Room 1569, 26 Broadway, New York City.—Gratis.*

TORFLEX FLEXIBLE BEARINGS is a four-page illustrated pamphlet which describes typical applications of these bearings which are specifically recommended for the elimination of noise, vibration, and lubrication; for impact and shock absorption; and for parallel and angular misalignment compensation. *Harris Products Co., 5474 Commonwealth Avenue, Detroit, Michigan.—Gratis.*

TOP NOTCH SHOCK RESISTING TOOL STEEL is a folder of special interest to makers and users of tools and dies for cold work or semi-hot work applications where resistance to severe and repeated impact is important. Contains complete information on heat treatment of the steel. *Jessup Steel Company, 680 Green Street, Washington, Pennsylvania.—Gratis.*

PLANTS AND CHEMICALS, by W. E. Bott, is a 32-page booklet containing instructions for amateur experimentation to obtain plant mutations by means of the chemical, colchicine, also for the use of hormones and vitamins in plant experimentation. *W. E. Bott, Box 2648, Lakewood, Ohio.—25 cents.*

TABER ABRASER RESEARCH MODEL, bulletin 4012, is a six-page illustrated folder which describes the uses of an efficient testing machine for evaluating resistance of surface finishes, as well as textile fabrics, to rubbing abrasion. This equipment can find a definite place for itself in all modern laboratories where abrasion resistance must be determined. *Taber Instrument Company, North Tonawanda, New York.—Gratis.*

IT SANDS, SAWS, HONES, FILES is a four-page bulletin that describes several models of reciprocating multi-purpose hand tools. It tells of the many operations that can be accomplished with these tools, as outlined in the title. *H and H Research Company, 12540 - 12th Street, Detroit, Michigan.—Gratis.*

Printed in the U. S. A. Press of the Wilson H. Lee Company, Orange, Connecticut.

AS AN INTEGRAL part of our system of national defense, the entire trucking industry of the United States has been organized to co-operate with the Army. The story of this organization and of the methods employed is told in the article starting on page 349 of this issue.

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SCIENTIFIC AMERICAN

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NINETY-SEVENTH YEAR • ORSON D. MUNN, Editor

JUNE • 1941

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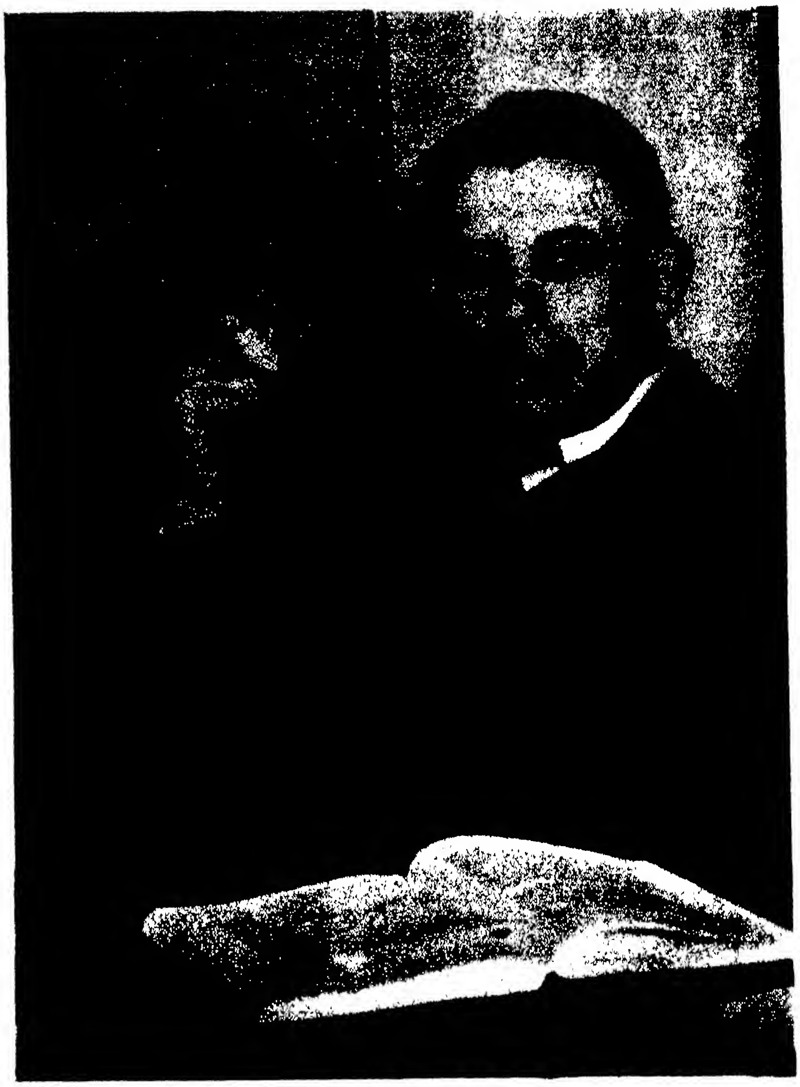
Personalities in Science



EDWARD A. DOISY

DOCTOR DOISY, now 47 years old, is head of the Department of Biochemistry at St. Louis University. The most recent recognition of his many achievements came in February, 1941, when he was awarded the Willard Gibbs medal, one of the highest distinctions in chemical science, for first isolating and determining the chemical structure of vitamin K, the blood clotting principle.

In 1923, the same year Dr. Doisy joined the faculty of St. Louis University, he began research, in collaboration with Edgar Allen, now of Yale, on female sex hormones. Six years later he succeeded in isolating theelin, an estrogenic hormone, effective in restoring to equilibrium upset feminine endocrine systems. Since about 50 percent of all women will find estrogenes useful as a remedy for nervous ailments occurring during middle age, Dr. Doisy considers the isolation of these hormones one of his most valuable contributions to medical science.

Five years ago Dr. Doisy, assisted by four expert chemists and one technician, began work on a new chemical problem. Baby chicks, when kept on a restricted diet, died of blood seepage. Why? Something vitally necessary was lacking. But what was it? For want of a better word, scientists had called it vitamin K. Dr. Doisy and his companions worked day after day from early morning till almost midnight to solve the puzzle, but it was not until 1938 that they had a substance pure enough to designate it as having characteristic vitamin K activity.

Vitamin K, a fat-soluble vitamin, promotes the production of prothrombin, a constituent of the blood which enables it to clot. The vitamin is present in green leaves, especially in spinach, alfalfa, and kale. If prothrombin is insufficient to form a clot, blood will continue to flow from a wound until death ensues. Such prothrombin deficiency exists in newborn infants and in patients who have obstruction of the bile duct.

Of the more than 2,000,000 babies born in the United States annually, about 1.4 percent, or 28 000, die within seven days after birth, and specialists state that from 20 to 35 percent of these deaths are due to a lack of vitamin K. That means that about 8000 lives can be saved each year in this country alone by the use of this vitamin. Although Dr. Doisy was not the first to recognize vitamin K activity, he is the first to recognize two vitamin K's, K_1 and K_2; and the first to announce the chemical structure of each. As a result of this knowledge of their structure, he compounded a synthetic vitamin K_1 in the laboratory that is even more active than the natural vitamin.

Dr. Doisy received the gold medal of the St. Louis Medical Society in 1935, the Philip A. Conné medal of the Chemists' Club of New York the same year, and the St. Louis Civic Award in 1939. He is a member of the American Chemical Society, the American Society of Biological Chemists, the Society for Experimental Biology and Medicine, the American Institute of Chemists, and the National Academy of Sciences.

During his vacations, Dr. Doisy travels over the country in search of good fishing and the thrill of landing a prize game fish. Next to his love for angling, he has an energetic enthusiasm for shooting. Forming himself, his sons, and two bird dogs into an expedition, he likes to venture into the haunts of the quail. In his shorter periods of leisure he wields the driver, the niblick, and the putter on one of St. Louis' country club golf courses.

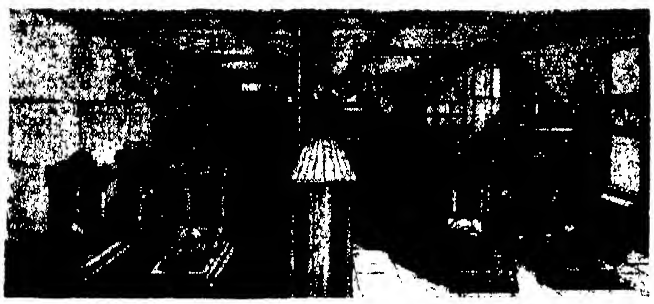
50 Years Ago in . . .

Scientific American

(Condensed From Issues of June, 1891)

TUNNEL—"The successful driving through of the tunnel beneath the St. Clair River at Sarnia, for the Grand Trunk Railway, under the direction of Mr. Hobson, of the A. S. C. E., is an achievement that will inaugurate an era of special activity in works of a similar character elsewhere. It is 6,000 feet long between the portals, 2,290 feet being under the river proper. It was driven through soft clays by a cylindrical steel shield forced forward by 24 hydraulic rams. . . The rams worked independently, and with such accuracy that after a year's driving at the rate of 8 feet per day, the two shields coming from opposite directions met exactly in line and level, having at no time varied more than two inches from true position."

POWER STATION—"The Edison Electric Illuminating Company, of Brooklyn, N. Y., have erected and put in operation an electric lighting station which in all its appointments ranks with the most advanced works of the kind in existence. . . The consumption of coal is brought down to a low figure, and perfected apparatus is provided



Dynamo room and regulating gallery

for ascertaining exactly what coal is burned. Thus a statement as to the pounds of coal consumed per electrical or mechanical horse power is entitled to the fullest confidence. . . The steam is supplied by eight Babcock & Wilcox tubular boilers. . . The dynamos are self-exciting and shunt-wound, and are built for an output of 575 amperes at 140 volts, but in practice are run at 650 amperes at 128 volts. Each one thus represents an output of about 112 electrical horse power and can supply 1,500 lights, representing a total of 21,000 lights in operation. . . The lamps are charged for at the rate of one cent per hour of use, and are replaced free of cost to the consumer as they fail. The well known Edison meter is used to determine the amount of consumption."

RAILROADS—"There were built in the United States, in 1890, about 6,344 miles of new railroad, giving an aggregate of 167,741 miles, or 44 per cent of the total railway mileage of the globe."

IRRIGATION—"A dozen irrigation canals are now completed, or under construction, with bed widths of 50 ft. to 70 ft. with main lines from 50 miles to 100 miles long, with as many more miles of laterals, and having capacities varying from 1,000 to 1,500 second-feet. Such canals will irrigate from 100,000 to 150,000 acres each, and will render habitable twice that area, supporting on an average 3,000 families each."

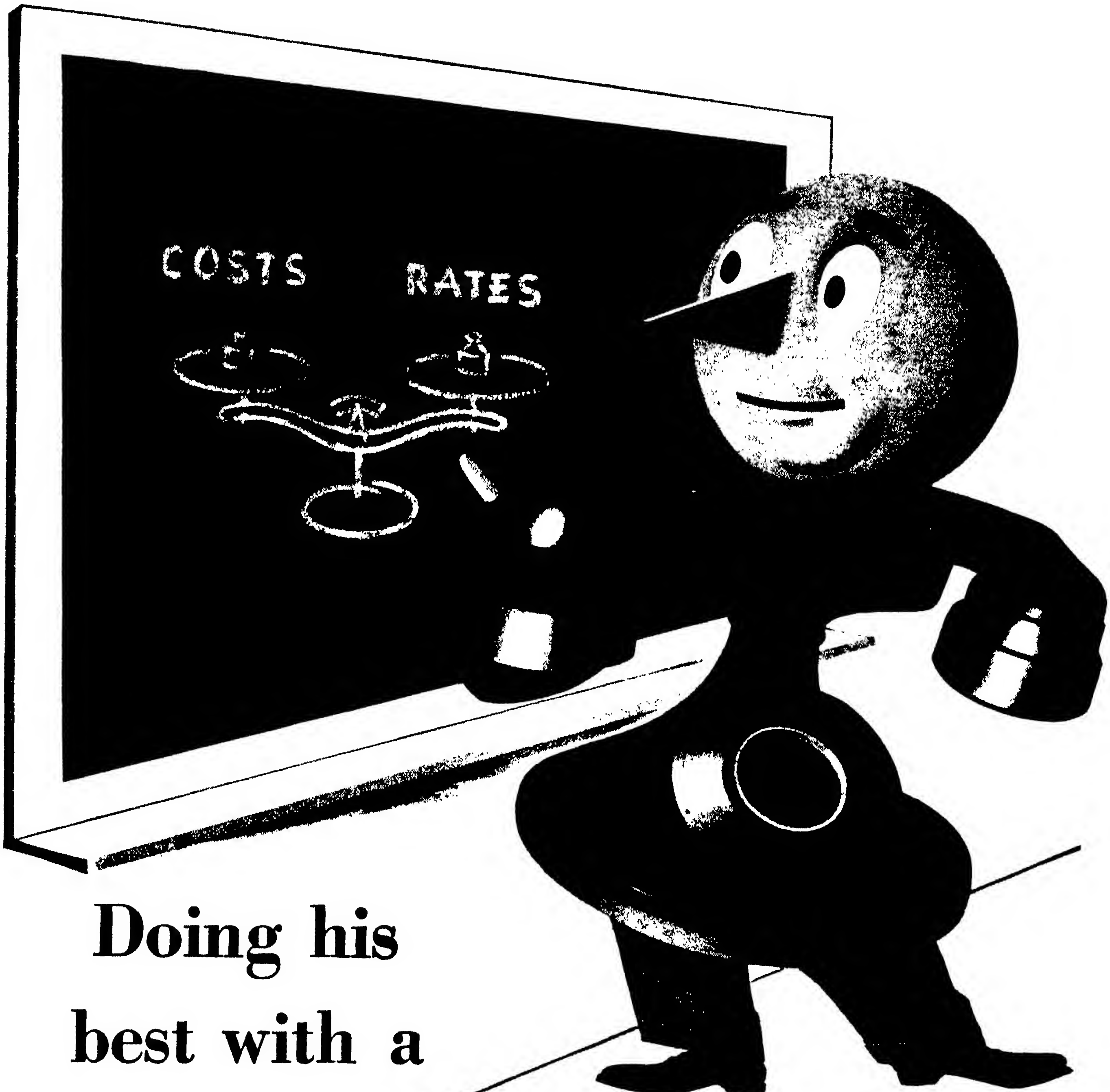
CAMPHOR—"Although the camphor tree is a native of China, Japan, and Formosa, the authorities of the United States Department of Agriculture state that it has been a subject of distribution by the department for nearly thirty years. . . While the camphor tree flourishes best in warm climates, it will stand 20 degrees of frost without being injured, and any locality where the thermometer does not show lower than 20° F. is fitted for the growth of the plant. . . Interest in the growing of camphor trees has recently been stimulated by the great increase in the price of gum camphor. This advance was caused by the quantities of the article which have been used in the manufacture of smokeless powder, and also by the increasing demand from makers of celluloid goods."

BIRCH OIL—"A profitable industry, and one of which but little is known to the world at large, is carried on among the hills of New England. It is the manufacture of birch oil. . . Birch oil has a market value as a flavor. It is used largely in the manufacture of confectionery and is sold, almost invariably, under a label that calls for the essence or extract of wintergreen. Pure extract or essence of wintergreen does not exist, nor is there any need of it, for the clarified oil of birch gives one a perfect wintergreen flavor, and it is so pungent that the smallest drop placed upon the tongue will blister it."

FLYING MACHINE—"Mr. Hiram Maxim, well known for his many ingenious inventions, has for some time past devoted considerable study to the subject of aerial navigation. . . Mr. Maxim says he has already expended $45,000 on tests, and is now at work on a large machine of silk and steel, with a plane 110 ft. by 40 ft., with two wooden screws 18 ft. in diameter. A petroleum condensing engine will furnish the power."

ELECTRIC RAILWAY—"While electricity may not yet be able to take the place of steam as an economical motive power for railway trains, it is demonstrating its ability, when properly managed, of cutting into the business of existing steam railways. The latest illustration of this is to be found in the passenger travel between St. Paul and Minneapolis. Until recently the steam railroads have controlled this business, but an electric road is now running between the two cities, connecting with the street lines of both, and in the half year which it has so far served the public it has taken such a large portion of the patronage from the steam railways that the latter will probably withdraw from competition for the local passenger traffic between the two cities."

PROPELLER SIZE—"Screws for steamers used to be made as large as possible, it being the theory that the greater the diameter, the higher the speed. A vessel was placed on Lake Erie with a screw so large that it was deemed best to cast each blade in two parts, and then weld them together. During a storm all these blades of the propeller broke at the welding, reducing the diameter by more than two-thirds. To the surprise of the captain the vessel shot forward at a speed such as had never been attained before. Engineers then experimented with small propellers and discovered that they were much more effective than large ones."


COSTS
RATES

Robert Yarnall Richie photograph, courtesy Jones and Laughlin Steel Corporation

RUNNING A STRING OF OIL-WELL CASING

GEOLOGISTS constantly search for new sources of oil, for new methods of reclaiming more of the black gold that lies in producing or apparently exhausted fields, as told in the article on page 352 of this issue. Keeping pace with these scientists are the crews of workmen who drive ever deeper into the earth, following the leads of the geologists, ever developing tools and techniques that make possible faster drilling, deeper wells, safer operation.

97TH YEAR **SCIENTIFIC AMERICAN** JUNE 1941

OUR SEARCH FOR THE SUPERNATURAL—III

Demonstrations of Rappings and Ectoplasm Explained

A. D. RATHBONE, IV
Secretary, Scientific American Committee for the Investigation of Psychic Phenomena

IN ACCORDANCE with a decision of the Scientific American Committee for the Investigation of Psychic Phenomena, the medium, Rose Ann Ericson, was permitted a second opportunity to demonstrate her psychic powers during the evening of Monday, March 31. As surrounding conditions had not been deemed conducive to best possible mediumistic efforts on the occasion of her first attempt, reported in our May issue, the Committee endeavored to improve them. Through the courtesy of the Hotel New Yorker, a completely darkened fourth floor room was made available, and in the presence of 35 witnesses, including members of the Committee, representatives of the press, photographers, and guests, the seance began shortly after eight o'clock.

As in the previous instance, Madame Ericson was seated at a table in the front of the room, facing the audience. On either side of her, and each holding one of her hands during the demonstration, were seated Dunninger, Chairman of the Committee, and A. Paul Peck, member of both the Committee and the Universal Council for Psychic Research. Care was taken to examine adjoining rooms to see that they were empty and that all doors to these rooms were locked. Other members of the Committee were seated in the front row to facilitate observation, and a photographer was stationed in a position suggested by the medium and instructed to take flashlight pictures at moments to be designated by her.

The lights were extinguished, utter silence was requested, and the audience was invited by the medium to join in singing, accompanied by a phonographic reproduction of "Seated One Day at the Organ." A miniature, electrically lighted candle, placed on the table in front of her and heavily shrouded with a handkerchief, threw a faint glow on Madame Ericson's face. Following the first musical rendition, the phonograph played "The Lord's Prayer," and the voices of some of those present blended softly in singing the hymn.

PSYCHIC RESEARCH

● **Scientific American, in collaboration with The Universal Council for Psychic Research, offers $15,000 to any medium who can produce a spiritistic effect or a supernatural manifestation under the rules and regulations published on page 210 of our April 1941 issue.** ●

A moment or two passed. Then the medium's voice was heard, and the music and singing ceased abruptly. In a slow, calm, unruffled manner, Madame Ericson said that she could see a "gentleman and two young men. They have been over quite a while. They passed over in an accident. Does anyone recognize them?"

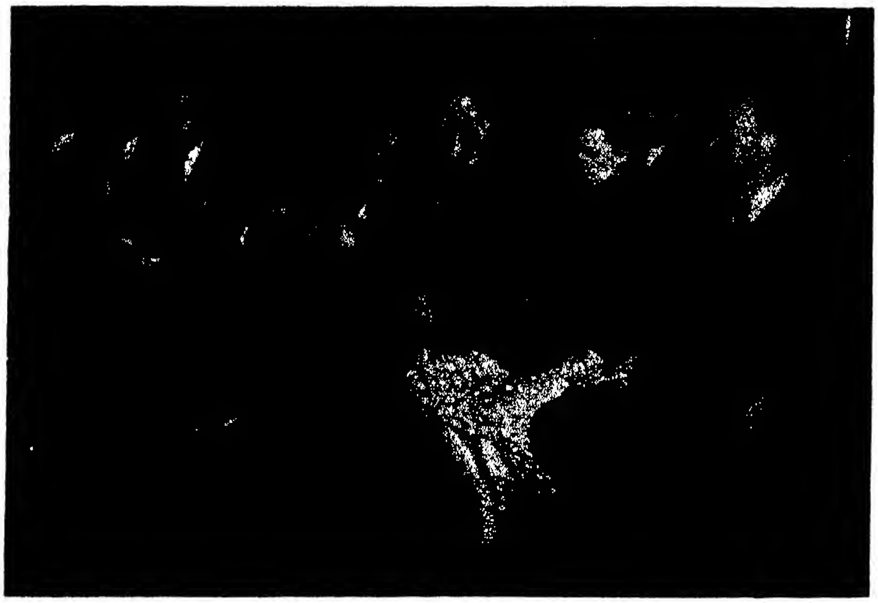
There was a pause, but no one answered. The medium then said she saw a young child with a speech impediment, that the person in the audience concerned with the child was not well. The initials of this person, she continued, "are J. K.—J. K.—is there anyone here with the initials J. K.?"

Mr. Joseph H. Kraus, member of the Committee, admitted the initials, but said that he could not recognize either the references or the description. Following a brief silence, Madame Ericson brought two other alleged spirit messages, one for a man who acknowledged his initials were "D.D." and one for a lady with the initial "O." There was another pause, after which the medium announced she would endeavor to contact the spirit of Mrs. Amelia Earhart Putnam, which she claimed to have contacted before.

A brief interlude of music was followed by complete silence, in the midst of which two distinct raps were clearly heard by those in the front of the room. Then Madame Ericson's voice, now slightly strained, said, "Thank you, spirit." She then continued: "I am greatly troubled in the place where I am. I cannot give you full details. I am disgusted by the comments of Colonel Lindbergh; he forgets the time when he crossed the ocean in a shoe box." [It was now evident that this purported to be the spirit of the late internationally known aviator, Mrs. Amelia Earhart Putnam, speaking through the mediumship of Madame Ericson.—*Ed.*] "We must hurry to prepare—there is great danger. I am a loyal American and I can and will send forth my spirit to help. I must warn you, do not listen to the remarks made by someone who does not know the full extent of the situation."

THERE was a sudden break in the message from the spirit of the aviator as the medium said: "Keep your eyes to the right—to the right —out from the table. I see eyes, yes, there are eyes. Will you take a picture, please."

The dazzling flash of the photographer's camera light doubtless startled and momentarily blinded everyone in the room, but Dunninger spoke up quickly and said: "Where are these eyes? Did any

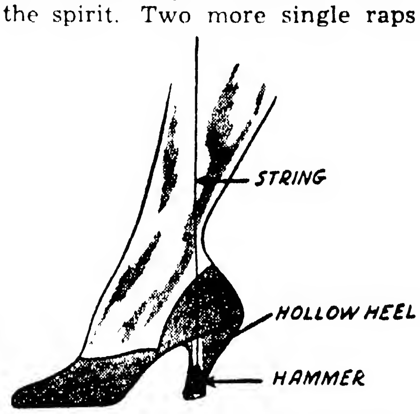


Although this picture was taken at exact instant "eyes" were alleged to be visible, neither audience nor camera visualized the phenomenon

member of the Committee see eyes? Did anyone see eyes?"

Mr. Kraus, who sat in the front row, stated he had seen something, that it appeared to be two lights, but that he could not be certain they were eyes. He added that what seemed to be lights might have been brought about by the after-effects of the flashlight bulb. The medium, however, asserted the entire form of the spirit had been clearly visible to her, but no one in the audience could substantiate the claim, nor did Madame Ericson describe the spirit's appearance.

Another short interlude of music was followed by a plea from the medium asking the spirit to "come over" and a statement to the effect that someone was making an "awful noise." There then ensued a period of silence followed by a single rap, then two raps, and a statement from the medium that she was finding it difficult to recall the spirit. Two more single raps



Another method of producing raps. Medium skilfully manipulates a string; hammer strikes

were heard and again Madame Ericson claimed that eyes were visible and that there was a strong psychic power extending directly across the table toward Dr. Thornwell Jacobs, the Committee member who was seated on the aisle in the first row. At the medium's request, two additional pictures were taken, after which an assistant asked that the lights be turned on.

Madame Ericson appeared to be tired, and during a brief rest period Dunninger again asked about the eyes. Had they been visible to anyone in the audience either on the first instance or the second? Mr. Kraus repeated he had seen two points of light, but that in his opinion they could have been after-reflections resulting from the flash bulb used in taking the photograph, and that he could see no resemblance to eyes. However, two people in the back of the room, later identified as Mr. Edward Rider, 121 West 72nd Street, New York City, and Mrs. D. Woods, 320 West 25th Street, also of New York, both asserted they had seen the eyes. These two witnesses were in the next to the last row of chairs and both were more directly in front of the medium than was Mr. Kraus, but no one else, not even those seated on either side of the aisles, and also directly in front of the medium, had been able to see any phenomena.

Dunninger then asked Madame Ericson if she could make one final attempt in order to test this apparent discrepancy. With the usual preliminaries, the medium tried once again, although it was evident that she was under a severe strain, and once more there was a series of rappings, after which the medium said, "Thank you, spirit," and continued with, "I am contacting some one. This person is coming back for the last time and to an individual in the front row. Can anyone see the figure? It is very plain. Please take a picture." This was done and the last demonstration, of extremely short duration, was declared terminated as the lights were switched on.

In summing up the evening's efforts, Chairman Dunninger said: "Once more we will have to depend on the photographs to determine whether there was any psychic phenomena present in this room, and the photographs will, of necessity, form the sole and conclusive evidence of the presence of a pair of eyes, inasmuch as only two people out of the entire audience

With restraining hand resting on fourth finger of medium's hand, ring finger is still free

feel positive that this phenomenon was present."

Subsequent development of the negatives gave no indication of the existence of any form of psychic phenomena at the demonstration.

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Report of the Committee on The Efforts of Rose Ann Ericson

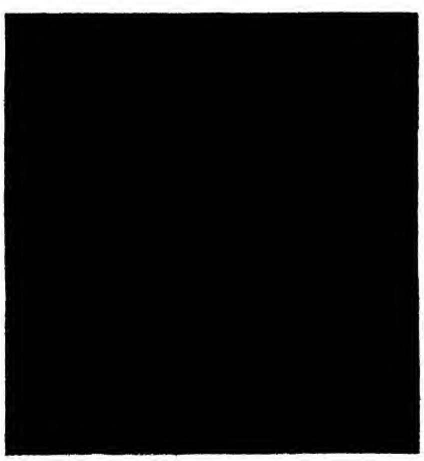
The Scientific American Committee for the Investigation of Psychic Phenomena later met to determine the degree of validity of such psychical phenomena of a physical form as had been demonstrated. Inasmuch as but two witnesses out of the 35 present claimed to have seen eyes, it was agreed that this did not constitute a sufficient number to warrant investigation of this phase of the demonstration, and it was felt that the surmise by Mr. Kraus, that the "eyes" could have been after-effects of the flashlight

bulb, was in all probability the correct version of the incident.

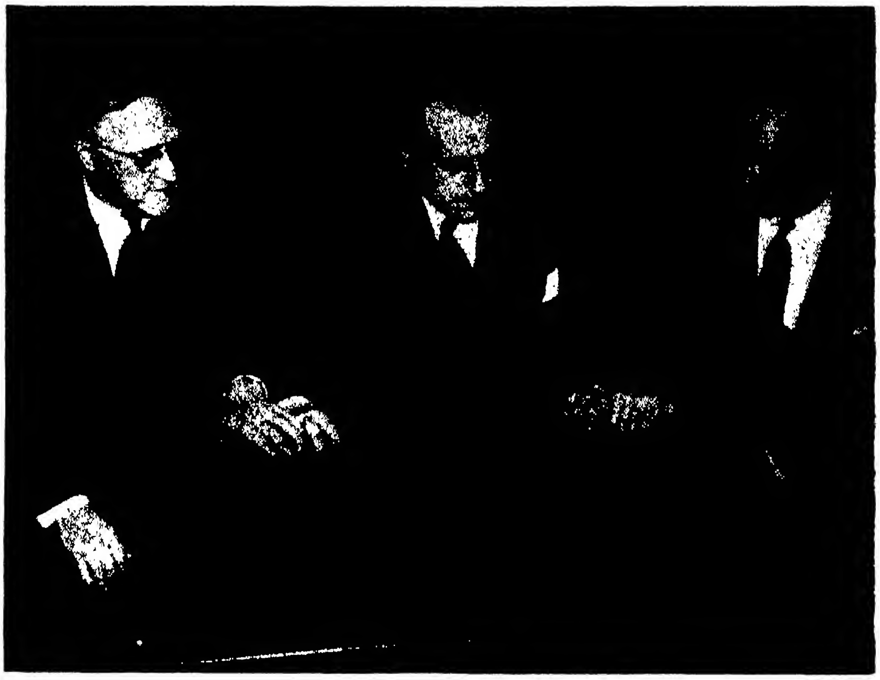
In view of the fact that the Committee is concerned only with psychic phenomena of a physical nature, the so-called spirit messages did not come within its jurisdiction, which left only the matter of the infinitely small ectoplasmic demonstration during the first seance—of which Dunninger had apparently been the only witness, due to the fact he sat next to the medium—and the spirit rappings heard at both seances, much louder and more frequently at the latter one.

"There are, therefore," Dunninger stated, "two things to be duplicated or explained through natural or scientific means—rappings and ectoplasm." Rappings, he explained, can be physically accomplished by several means, such as the use of the shoe against the leg of the table, or the manipulation of a large and heavy ring on one of the fingers. He called the Committee's attention to the fact that Madame Ericson's feet were neither bound nor in contact with those of any other person during either of the seances, and that she habitually wore a very heavy ring on her left hand, and had worn it on both evenings. In neither case, he pointed out, had she operated under test conditions, but had been given every opportunity to demonstrate her alleged psychic powers. Had she produced psychic phenomena of sufficient import to be observed by more than one or two persons, she would then have been subjected to severe test conditions.

Using his foot and his own ring, Dunninger demonstrated how rappings could be produced, even though the hands of the medium had been held by himself and by Mr. Peck. In this latter connection



Showing how an unguarded foot may be used against table leg



Dunninger demonstrates to Dr. M. Luckiesh, of General Electric Research Laboratory, and A. P. Peck how a medium may manipulate ring finger in total darkness, thereby producing rappings on edge of the table

he explained that the medium had several times asked him to turn on or off for her, as she desired, the small, shrouded electric light bulb which had stood on the table during both demonstrations, and each time he had complied with her request her hand had momentarily been free. She had not been requested to permit her feet to be in contact with those of others in order to prevent the use of her shoe against the table leg to produce rappings.

Dunninger explained that the effect of ectoplasm can be and has been accomplished in so-called spiritistic seances through use of a small vial or capsule, containing a concoction of such simple, everyday substances as glycerine, egg-white, and soap. Dioxygen, also, has been utilized. The tiny vial or capsule is easily concealed until the moment the medium desires to make use of it. Then, inserted in the mouth, or the capsule broken, the "mysterious" substance will appear on the lips. In the instance of Madame Ericson's first seance before the Committee, no one but Dunninger saw any evidence of an ectoplasmic substance, and as the medium's assistant had removed with her handkerchief the slight trace of foam from Madame Ericson's lips before Dunninger or anyone else could obtain a specimen for analysis, the Committee was in full agreement that the matter of ectoplasm needed no further consideration at this time. It was decided, however, that should another applicant for the award at some future time produce an ectoplasmic type of phenomenon of sufficient magnitude and duration to be observed by properly attested witnesses, a complete study of the subject of ectoplasm should then be made.

At the conclusion of its discussion of the two seances thus far held under its jurisdiction, the Scientific American Committee for the Investigation of Psychic Phenomena unanimously agreed that the medium, Rose Ann Ericson, had produced no psychic phenomena that not been satisfactorily duplicated or explained through natural or scientific means.

● The interest already exhibited by our readers and by the public at large in our search for the supernatural is indeed gratifying. Many letters have been received suggesting projects or phenomena which our Committee might investigate. Among these are a house which is reported to be inhabited by a vampire spirit; an alleged "spirit photograph," valued by the owner at $10,000.00, and other matters. As rapidly as possible they are receiving the attention of the Committee, and those that warrant further examination will be reported on in these columns in future issues. The Committee will at all times welcome letters, suggestions, and criticism, and acknowledgment will be made of such contributions as quickly as possible.—*The Editors.* ●

A Skin Game in Metallurgy

Longer Life and Greater Productivity Given to Tools and Machines by Heavy Chromium Plate

RAYMOND F. YATES

CHROMIUM supplies a skin over other metals that metallurgists love to touch. When deposited over inferior metals, chromium supplies a hard coat of armor that not only resists most chemical action but also, when present in sufficient quantities, wards off blows and parries frictional wear with truly remarkable efficiency.

Some notion of the power of chromium to resist mechanical abrasion may be had from the fact that automobile bumpers carry a deposit of the metal only 1/200,000 of an inch in thickness. Now, however, we are not so much interested in the decorative uses of the metal as we are in its use as hard, wear-resisting armor plate for the protection of steel, iron, and certain alloys. Harder by far than even the hardest steels, close-grained, tough, and capable of withstanding high temperatures without surrendering any of its valuable properties, chromium serves as the armor to shield many of its lesser cousins in the metallurgical field.

Although attempts to deposit chromium electrolytically were made as early as 1835, little or no success was had until the late 1920's when Fink, of Columbia, turned his skilled and fertile mind to the problem. Sargent, of Cornell, had stimulated interest in the matter during 1920 when he read a paper on the subject.

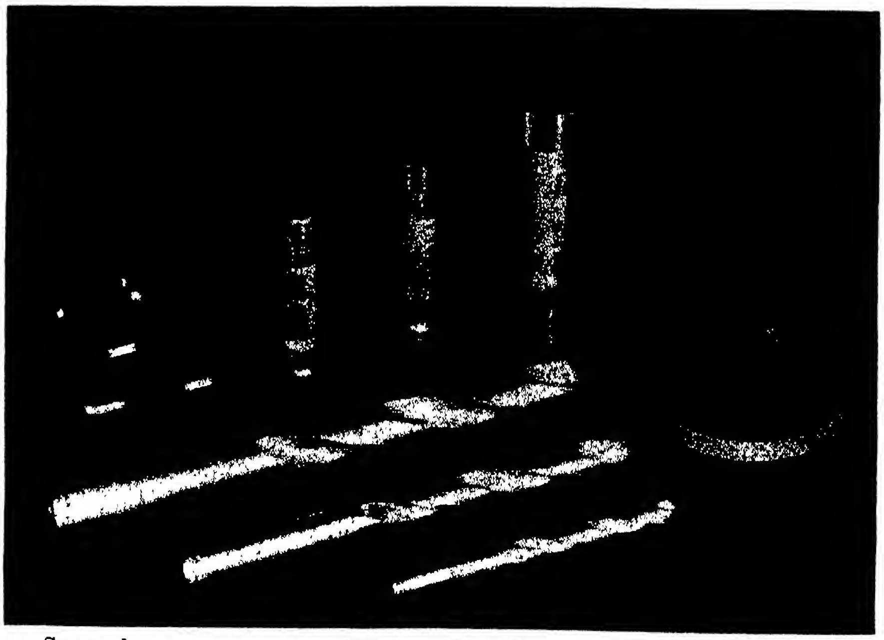
Perhaps the metallurgists of the United States Government Printing Office were the first to recognize the value of heavy deposits of the metal ranging .002 inch or over. Steel engravings for the printing of greenbacks were protected against early failure by surprisingly thin deposits of chromium. At that time, however, the deposition of really heavy plates imposed problems that for a time appeared almost insurmountable. When deposits ranged beyond modest thicknesses, microscopic fissures would appear and adhesion also became precarious.

Within a few years time, the researchers hung up still another hide on the barn door and chromium became available for making deposits as thick as .025 of an inch—about twice the thickness of a Government postcard. It is such deposits of chromium that are today working new miracles in the machine and tool field. Strangely enough, electro-deposited surfaces of the metal are harder than the metal refined by other means. They may run anywhere between 400 and 950 Brinell, depending upon the conditions of deposition and the nature of the basis metal.

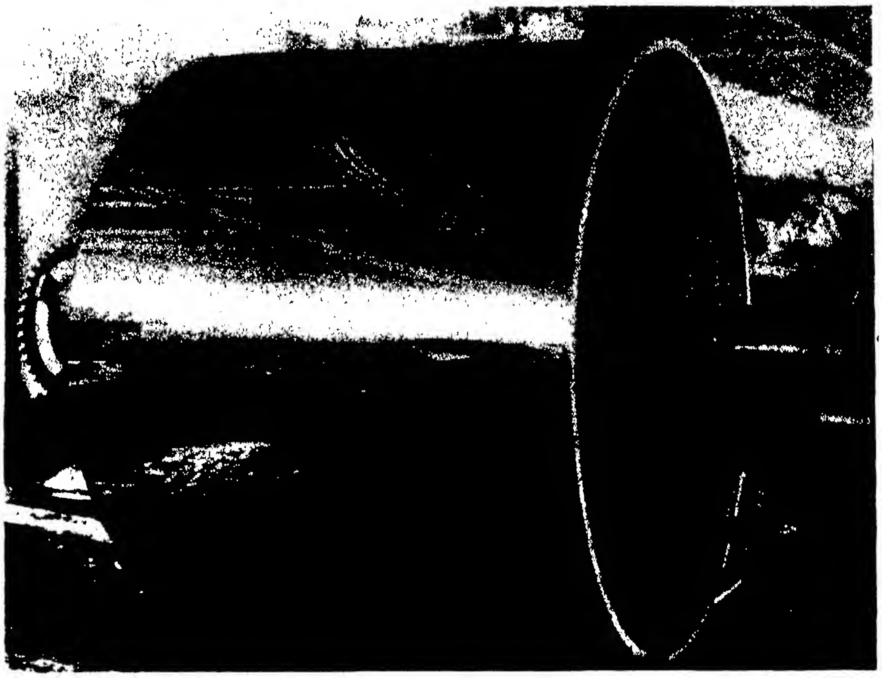
We can not hope to cover all of the applications and ramifications of our subject within the confines of this article; consequently we shall place emphasis on the more common uses of the metal. It follows also that the more common uses will naturally be the most important ones.

Dr. D. A. Cotton, of the Delco-Remy Corporation, was one of the early experimenters with hard-chrome, as it is now called, and many valuable innovations in the use of the metal issued from his busy laboratory. At the present time, Dr. Cotton is saving his company about $15,000 annually in reclaimed tools and gages alone. Plug, snap, and other types of gages are not only expensive but in a sense highly perishable. No matter how expensive the steel from which they are made, a few thousand applications finds them worn to the limit of tolerance. Until recently, it was necessary to discard worn gages and purchase new ones. Now, however, they can be placed in a hard-chrome tank for a short time and plated until they are oversize. They are then removed, ground down to size, and placed back in service actually better than new because they will not be reduced so rapidly. The process of reclamation may be repeated again and again and there is no reason why a single gage can not be used almost indefinitely. In such instances, really heavy deposits of the metal are not needed. They are usually less than .0005 of an inch. Yet even this extremely thin tissue of chromium puts up a far braver front than the finest grades of steel.

IT HAS been found that over 100 applications of hard chrome may be made in the average manufacturing plant—not only in the salvaging of worn parts but also in the preservation of accuracy, the reduction of wear on moving machine parts, and the increase of cutting and drawing efficiency. Nor



Snap plugs, gages, and drills are only a few of the tools of industrial production that gain longer life, greater efficiency, through hard chrome



Used in paper manufacture, this 72-inch diameter steel drum, face area 13,570 square inches, is chromium plated and polished to a high luster

is the process limited to old or used devices. Brand new files, after a few minutes treatment in the chrome tank, will cut 20 percent faster, last 400 percent longer, and show far less tendency to foul.

Among the more common tools benefited by hard chrome coverings are taps, dies, broaches, burnishing tools, drill jigs, hobs, rolls, chuck heads, cams, drawing dies, coining dies, header dies, and molds for plastic resins, rubber, and so on. In every case there are savings both in equipment and efficiency.

The manufacturers of certain machines are belatedly becoming cognizant of the superior qualities of chrome-plated surfaces. Many tools and other devices are now reaching the market protected by this metal.

As has been very aptly said, most metal working machinery represents what we might call "taking off" tools; the hard-chrome plating tank could very well be called the first "putting on" tool. With hard-chrome tanks coming into use in tool rooms all over the country, the machinist can easily get out of trouble in this way: He shuffles into the plating room, produces a chunk of steel from his coveralls pocket and says, "Say, Doc, can you put a half-thousandth back on for me?"

HERE is a story recently told. Work had been all but completed on a series of molds worth about $6000. From the engineering department came word that a slight but important change in measurement was imperative; indeed it amounted to the difference between success and failure. Metal that had been cut away must be replaced. A few years back, the whole $6000 worth of material would have been scrapped. Production would have been delayed and there might have been a change in personnel. Within three days time, however, and at a cost of about $200, the damage had been repaired by chromium. The metal, in this case, had to be deposited to a thickness of .024 of an inch. This thickness requires about 80 hours of continuous plating.

Some of the feats now being accomplished by hard-chrome experts are almost beyond belief. A mid-western producer of automotive accessories found that, through unavoidable conditions, a 3/16-inch square hole in 24 dies had to be made smaller by several thousandths of an inch. The job was done quickly, by chromium, with a saving of some $10,000.

The hard-chrome tank is also helping the punch press and the die maker over tough spots. It was found that a blanking and forming die used to produce a stainless-steel cap for an ignition lock had an annoying tendency to tear the work on the radius. Failure to produce clean work occurred at the end of every 1500 or so operations. A little hard-chrome in the right area brought the production up to 20,000 before the trouble re-appeared.

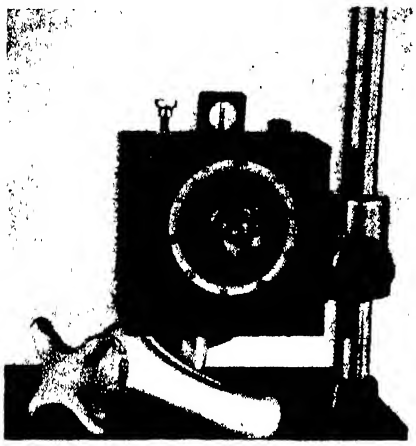
Prior to chrome plating, the principle use of chromium was in alloys. It was far too hard and too brittle to be worked by any known machine methods. Even the best grinding wheels fought a losing battle with it. Electro-deposition, however, made chromium buckle down, so to speak. It brought it under control and permitted it to be used as a casing for less able metals. Even as far as the art has gone to date, that which has been accomplished can only be an insignificant part of what the future holds.

A little chromium goes a long way. As little as 1/100,000 of an inch of the metal applied to a new drill permits it to be used from five to eight times longer in drilling non-ferrous and plastic materials. Such inexpensive treatment creates desirable economies.

Pressures up to 6000 pounds to the square inch are now being used in hydraulic presses in the plastics industry. Rams in the larger presses vary between eight and 14 inches in diameter and considerable expense is entailed in keeping the packing rings of such equipment functioning in a leak-proof condition. Even with normal eight-hour day operation, re-packing must be done monthly and the cost, to say nothing of the loss of the use of the machine, varies between $130 and $150. More and more, molders of plastic materials are turning to hard-chrome for help. One press, after having its ram plated with a thin deposit of this metal, remained in operation continuously for eight years without being re-packed.

CHROMIUM applied to draw dies not only permits them to hold up in service for a longer period but also prevents score marks and increases production. Punching dies of all types can be helped by chromium deposits. Up until a short time ago, however, it was thought that the extreme hardness and consequent brittleness of the metal would prevent it from being used successfully on dies of the shear type. However, this theory has now been pretty well battered down. Hard-chrome, placed over a large die intended for armature laminations has increased between-grinds production from 50,000 pieces to 150,000 pieces.

One finds chromium bobbing up



Thickness of hard-chrome plate is accurately measured, without destruction, by electrical gage

in the most unexpected places. It is now being used widely on soldering jigs but not alone to prevent wear. Due to the peculiar nature of the metal, other metals show little or no mechanical affinity for it. This is true of any kind of solder. The molten metal falls upon the chrome and promptly rolls off.

Often as little as an hour in the hard-chrome tank will produce sensational and fantastic results in prolonged life, increased production, and lowered costs. In making automobile horns, as an instance, it was found that a swaging die, used in the production of the horn proper, created trouble later in the welding operation. The engineering department finally overcame the difficulty by substituting a coining die. Here, however, a new headache developed. This die frequently galled and production was seriously interrupted several times daily. Some one in the plant thought of hard-chrome. The die was sent down for treatment. It came back a few hours later and proceeded to turn out nearly a million pieces without interruption before it was finally called out of service.

There are a number of mysteries about chromium and its ability to "take it." For instance, a very small difference in hardness readings on the scleroscope may mean great differences in wear resistance. A steel gage showing about 87 scleroscope reading will provide 9970 checks before the limits of its own tolerance has been reached. When such a gage is plated it may read as low as 97 and yet will stand up perfectly in service for 48,024 checks with wear at .0002 of an inch. Apparently the metal is not only hard and resistant; other metals passing over move with minimum resistance and hence minimum wear.

It is not in the machine-tool industry alone that hard-chrome is making all of the progress. Indeed, its applications are broadening out so rapidly now that it would be difficult to estimate the number of industries where it has become a factor. It is known, however, that both the paper and textile industries are feeling some of the many benefits of chromium plating. Deposits on large, heavy steel rolls are made as thick as .020 and it is not unusual to have such plating cost as much as $6000 a roller. Several days of uninterrupted plating is required. Because chromium plating requires as high as 1000 amperes per square foot, these larger rollers are slowly revolved through a trough of the solution with only a few square feet exposed at a time. Thus is the current consumption kept within reasonable limits.

This is by no means the complete story of hard-chrome. It is enough, however, to show definitely that here is something comparatively new on the industrial scene that is indeed worth watching.

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New Brazing Method Cuts Costs

Fusion Process at Arms Plant is Applicable Throughout Many of the Metal Industries

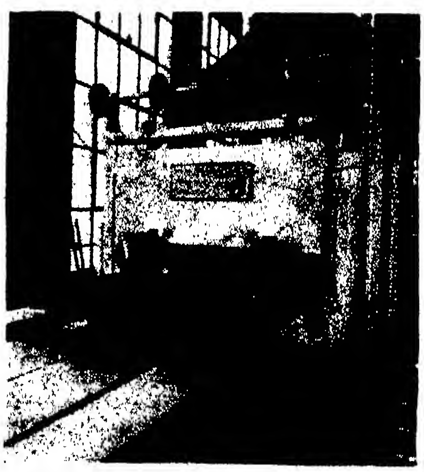
A. P. PECK

In an endeavor to introduce mass-production principles into the brazing of shotgun barrels — a hand-soldering process on each individual gun until now — there has been developed a gas-operated brazing furnace for which application will be found in almost any branch of industry where fusion of metals is a necessary part of the manufacturing operations. This new furnace effects a union between shotgun barrels heretofore unequalled in strength, is so clean in its operation that most of the grinding, filing, and polishing formerly necessary in gun manufacture has been eliminated, and offers other potential economies to metal-working industries.

It all began when Frank T. Green, of the J. Stevens Arms Company, invited M. R. Utley and B. K. Walpole, of the National Gas Furnace Company, to design a mechanism capable of brazing 200 sets of shotgun barrels a day, thereby inaugurating the first radical change in almost a century of scatter-gun barrel construction. After accepting this challenge, earlier refused by other engineering and research organizations who said it couldn't be done, the furnace was constructed, installed in the Stevens factory, and experimental operations were begun.

Today, the arms company, with the aid of the new brazing furnace, is turning out 400 sets of gun barrels a day, has eliminated a number of cumbersome operations, reduced labor cost 40 percent and, in producing the only all-brazed shotgun now manufactured, has cut down the "touching-up" operations on the joined sections by 80 percent. Outstanding among the improvements achieved by the new braze are the additional strength imparted to the barrels where they are fastened together, the cleanliness of operation, and perfect alignment of shell chambers and barrels.

As many shotgun owners have



Tray-load of shotgun barrels entering new brazing furnace

learned to their sorrow, the soldered twin barrels of a shotgun will occasionally split apart at the rib under sudden changes in temperature. Intense shooting heats the barrels to a degree decidedly uncomfortable to the bare hand, and, under such conditions, when the metal has cooled too sharply and abruptly, the barrels have been known to split apart, or the connecting rib to come loose.

A tension load of about 60 pounds has been capable of pulling the rib loose from the old solder braze. In making such tension tests, sections one-quarter inch long were sawed out of the barrels midway between breech and muzzle. Each section was tested by suspending one barrel from a fixed bar and applying a static load by hanging weights from a hook secured to the other barrel section, the load being gradually increased until the joint between the barrels gave way. An average of the test loads indicated a tensile strength of about 60 pounds for the joint. Not so with the new process. Under similar tests it was found that excessive pressure would tear the metal of the barrels themselves before the braze would let go.

A tray of shotgun barrels comes from furnace about every fifteen minutes

Left: **Ready for brazing.** *Right:* **Barrels emerge clean, free from burrs**

As to cleanliness of operation: Pitting of the metal, often excessive under the old 2000 degrees, Fahrenheit, process, has been entirely eliminated, as has also warping of the chamber section. Grinding and polishing the brazed barrels and butts to eradicate pitts, burrs, and lead spots is no longer required. The tedious hand-filing and cleaning-up process, always a necessary evil in shotgun barrel manufacture, is now as antique as a muzzle-loading matchlock. Furthermore, it has been found that this trait of "sanitation" is particularly acceptable in the building of the over-and-under combination rifle and shotgun, which incorporates a .22-caliber rifle barrel and a .410 bore shotgun barrel in the same firearm. For obvious reasons the rifle barrel must be rifled before its marriage to the shotgun barrel, yet when one of these combinations comes out of the furnace, and subsequent light pickling tanks, the barrel interior is so perfect that it is only necessary to hand-wipe it, and the grooves and lands of the rifling are as clean as the proverbial hound's tooth.

The furnace utilizes ordinary illuminating gas and brazing is accomplished at a relatively low temperature, the "atmosphere" within the furnace being in reality a by-product of the burned gas used for heating, but the secret of the process lies in perfecting control of both temperature and time to the Nth degree. The rate of cooling after the braze has been completed is fully as important as control within the furnace itself, so great care is taken to maintain the correct degree of heat throughout the long cooling chamber and properly to time the cooling period.

To accomplish this a number of carriages are moved along a grooved track by an endless chain. Five of the carriages, each with its load of gun barrels, are in the 32-foot long apparatus simultaneously, one being in the furnace proper while four are in the cooling chamber. Through months of arduous trial and error, during which thousands of gun barrels formed the basis of experimentation under the sharp scrutiny of experienced barrel inspectors, it was learned that the entire process requires about one hour for five loads, depending on the type of barrels, from entry into the oven proper to exit at the end of the cooling chamber. As each carriage transports from 10 to 15 double barreled shotguns, it will readily be seen that after all these years a method has been found to apply mass-production methods to brazing operations in the shotgun industry.

Skill and care are needed in preparing the barrels for brazing, there being seven separate pieces in the complete assembly. As the breech of the barrel is heavier than the muzzle, because of the presence of the breech lug that later becomes part of the breaking and locking mechanism, and as thickness of barrel walls varies from butt to muzzle, the location and tension of the encircling wires shown in one of the photographs are important factors. They, together with judicious use of heat equalizing bars and shields, help to counteract the variations in expansion and contraction of the different thicknesses of the metal, but, again, the real key to the process lies in absolute perfection of time and temperature control.

A special brazing alloy, which flows easily at even lower than the critical temperature of barrel steel, and a flux which fuses by capillary action, are placed at points along the joined sections of the wired barrel assembly. This brazing alloy, it is said, is as costly per

ounce as is the customary solder per pound, but as less of it is needed, as there is practically no waste, and because of mass production and reduction of operations, the total material cost per gun has actually been reduced.

The actual building of the furnace did not present so much a problem of manufacturing as it did one of lengthy research and engineering. Thus, 140 years after Eli Whitney evolved the first principles of American mass production to fulfill his contract for United States Army rifles, the arms industry is again responsible for a manufacturing process, the possible applications of which are relevant to almost any branch of industry where fusion of metals is a necessary part of the operations.

• • •

FOIL SUBSTITUTE

Coated Paper to Replace Aluminum

MORE and more is going to be heard in the near future about methods and materials for replacing those substances which are essential for national defense and, of course, aluminum is the metal which is foremost at the present moment in this particular respect.

Aluminum foil has been widely used by the packaging industry in the past, consuming a considerable amount of this vital strategic material. Now, however, there has been introduced by the Reynolds Metals Company a substitute for this foil.

The finish of the new product is equivalent to a matt-finished aluminum, silver, gold, or colored stock, and is produced by coating a hard finished paper board with an aluminum powder compound made from scrap. This coating in turn is covered with a clear or colored plastic finish. It is stated that while this new finish actually costs more than does aluminum at present prices, the manufacturers believe that it can eventually be produced at comparable cost.

MATTING

Tested on Floors Soaked With Oil

NEOPRENE floor matting, designed specifically for use where it might be exposed to oil, has proved its worth in a test installation where more oil is present than is ordinarily found in any industrial location—the oil processing rooms of an oil refinery.

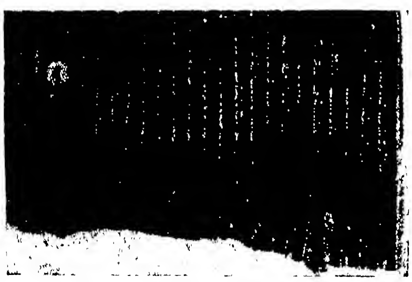
In this test, strips of rubber and neoprene floor matting were installed in two locations where oil would be present on the floor to the greatest extent.

The first location was the floor in front of oil can filling machines. Here the mats were constantly subjected to spillage from the machines and were walked upon by the workmen. At the end of three months the standard rubber mat was quite changed in that the material was soft and spongy. The neoprene mat did not appear to be any different in appearance or condition than at the start of the test. These facts are indicated to some extent by photographs of the corners of the two mats which show exactly how the mats looked when they were taken from the floor.

A second set of mats — rubber and neoprene — was placed beside a grease cooker. During the period of the test, three months, both mats were subjected to heat, oil, soda lime, and considerable traffic from steel-wheeled trucks. At the conclusion of the test the neoprene mat did not appear to be affected by this severe service except for indentations caused by heavy drums which stood upon it throughout the test. The rubber mat was very soft and it had deteriorated badly in spots.

After the mats were removed from the test location, they were turned over to the laboratory where accurate measurements further demonstrated the value of the neoprene products for this type of service.

Inasmuch as this test subjected the matting to service considerably more severe than that usually encountered, it enabled a rapid determination of the comparative value of the neoprene matting. The results demonstrate the superiority of neoprene for use where petroleum oils and greases are present in appreciable quantities.




Comparison tests of rubber and neoprene matting. See the text


MOLDING

Extruded Plastic Replaces Metal Strip

THE diversion of aluminum and other metals to purposes of national defense has resulted in many substitutions of other materials. In the past, extensive use has been made of extruded aluminum and bronze for moldings of various kinds. Cover moldings for joints and corners of walls made of sheets of wallboard, plywood, and so on, have hitherto been made principally of these two metals, as well as of chromium-plated steel. To replace these, there is now available an extruded plastic molding that is being turned out in shapes duplicating the metal strips formerly used. One of the plastics used for this purpose is extruded Tenite, the finished molding being designed so that it will hold itself in position.

Since this material hardens simply by cooling, the molding can be rapidly extruded in any desired shape and immediately coiled or cut to length. It is produced in finished form; no further processing or shaping is necessary.

Because of the design of Tenite molding, it is possible to place the plastic along the seams and fit it into the cracks. Once inserted, the molding is held firmly in position by a flanged portion of the strip which prevents the plastic from loosening, just as the barb of a fish-hook prevents the hook from being readily withdrawn.

These plastic moldings are produced in a wide range of color which gives the architect great freedom in design. The color is an integral part of the plastic and will not chip or wear off.

CHROMIUM TEST

Salt Spray Checks Plating Efficiency

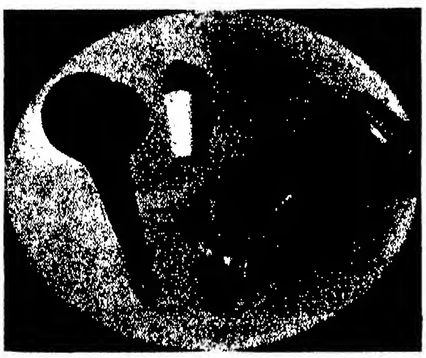
SALT spray, notorious enemy of practically all bright or plated metal surfaces, is being used to test chromium plated parts for automobiles. In the Pontiac plant it is reported that all such parts are placed for 24 hours in a salt spray cabinet, during which time a continual spray of cold water containing a 15 percent solution of brine plays on the parts. The least evidence of rust after this 24-hour exposure is sufficient cause for rejecting any part.

A sidelight on these tests is that it has been determined that the depth of chromium plating has but little bearing on its ability to withstand rust. Smoothness and freedom from tiny breaks or pinholes are the most desirable qualities of chromium plating.

METAL SAVING

Plastics Fill Needs in Many Fields

STILL another example of the substitution of plastics for metals is that recently announced by the Closure and Plastics Division of Owens-Illinois Glass Company. This organization is now manufacturing, out of plastic materials, many items which formerly were available only in aluminum.



Formerly made of metal

Among the most recent of the products which fall in this category are a polystyrene funnel, standardized teaspoon for medicinal dosages also made of polystyrene, a plastic measuring spoon for coffee, and a two color inhaler of opaque plastic which already is in use in the field of proprietary drugs.

Officials of Owens-Illinois say future developments in this field are limited only by the imagination of designers and the ability of manufacturers to keep up with the demand for new molds.

PRODUCTION WELDING

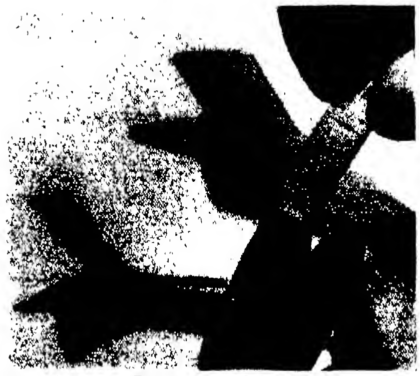
High-Speed Process for Aluminum Alloy

A NEW high-speed production process for spot welding aluminum sheet for aircraft use features

Simplified, standardized welding

extreme flexibility of equipment. Announcement by the Progressive Welder Company says that the process permits welding of aluminum sections as thick as ¼ of an inch or of the thinnest weldable sheet on the same machine with a minimum of adjustments on the part of the operator.

Capable of producing spot welds far beyond the strength required by government specifications, the new process involves economical equipment and does not require any special skill in operation. Welding speeds are comparable with those



***Above:* Range of aluminum welding; two samples welded by same machine within a few minutes of each other. *Below:* Photo-micrograph of weld shows freedom from cracks, blow holes**

customarily used with welded sheet steel and are limited only by the speeds at which the work can be moved between welds.

Uniformity of welding is claimed as one of the desirable features of this process, a microscopic examination showing the welds to be virtually free from cracks and blow holes.

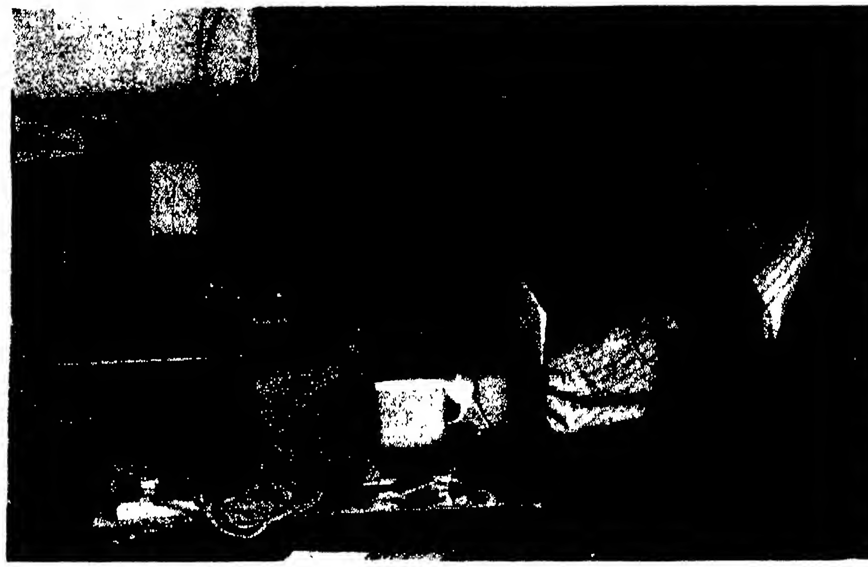
There are many problems involved in successful welding of aluminum, particularly in production work. The metal has a low electrical resistance and therefore requires a large amount of current to obtain a satisfactory weld. Since the plastic range of aluminum is extremely short, the current must be "on" for only a short interval. Also, welding pressure must be accurately controlled and balanced with the current flow in order that excessive surface indentation does not result in the metal being welded.

The new process consists, essentially, of passing the current through a converter, which eliminates the negative portions of the alternating-current wave. The resulting pulsating current has a time cycle of 300 degrees instead of the 360 degrees. The current then passes through the welding transformer. The resulting secondary current wave form is ideal for welding aluminum. The current rises to its maximum almost instantly, stays at this value for

practically the entire duration of the weld, then drops to zero in an extremely short period of time.

Welding pressures are obtained through an air-operated pressure cylinder which is mounted on the upper arm and actuates the upper welding electrode, and are so handled as to provide a "follow-through." To provide a closer and more positive connection between welding transformer and work, an air-operated secondary shunt clamp grips the upper electrode after the work is under welding pressure.

Automatic repeat timing, which allows sufficient interval between welds to re-position the work, permits making any number of welds in succession automatically.



R. S. Hunter working with the multipurpose reflectometer

REFLECTOMETER

Photo-Electric Instrument For Industrial Use

MEASUREMENTS of color, apparent reflectance, and specular gloss are used in the ceramic, paint, textile, paper, and chemical industries to help describe in numerical terms the true appearance of materials. A multipurpose reflectometer to measure these quantities photo-electrically has been designed by R. S. Hunter, of the Photometry and Colorimetry Section of the National Bureau of Standards, and is described in the Bureau's Research Paper RP1345.

Of the many different uses of the apparatus, the following are noteworthy: The instrument measures the apparent reflectance, the hiding power, and the opacity of paints, papers, and porcelain enamels. Measurements with it will help in evaluating the efficiency of soaps and detergents for cleaning fabrics. With the proper spectral filters, the device may be used in determining the magnitude and character of color differences between samples which are similar to each other in color. Settings with these filters provide a basis for evaluating the whiteness, yellowing, fading, bleaching, bluing, and tinting strength of textile materials. With different filters, chosen to transmit narrow spectral bands, the reflectometer may be used for abridged spectrophotometry. The values of specular gloss measured with the instrument are used to evaluate the shininess of surfaces and to classify paints and other materials for gloss. With an attachment which has been designed, the instrument will measure the transmissions of non-diffusing liquids, glasses, and plastic samples.

In the reflectometer, two light beams from a single source are directed along separate paths to two photo-cells. For each sample tested, there is a photometric adjustment to restore equality of currents. The amounts of photometric adjustment are measured on direct-reading scales, one of which is used for apparent reflectance and the other for specular gloss. Because of its high precision, the reflectometer is especially suited for measuring small differences in apparent reflectance, gloss, or color of nearly identical samples, thus eliminating guess-work of the human eye, and providing accurate measurements for industry.

GLASS PUMP

For Handling Corrosive and Other Liquids

A CENTRIFUGAL pump in which all parts are made of Pyrex and which has a capacity of 10 gallons per minute has been perfected and is now available for small laboratory installations and pilot plant services. This pump is a junior model of a similar type of larger capacity which has already proved itself in active service. It is highly desirable where corrosive liquids are to be handled, or where liquids which are pumped from one point to another must be kept chemically uncontaminated. A mechanical seal replaces the conventional stuffing box, and a safety unloading device eliminates the possibility of fracture of the glass case.

All glass

This pump, designed to handle hot acids or brine cooled liquids with equal facility, should offer the solution to many chemical process and food plant problems.

GRID MAKER

Automatic Machine Makes Vacuum Tube Parts

IMPROVED efficiency in manufacturing grids used in radio tubes has been achieved by a new automatic grid machine perfected by the RCA Manufacturing Company. The machine produces grids ready for use, except for cleaning.

The new grid machine is a fully automatic device as compared with the lathes used for winding grids under the older method. Full-turn grid spirals are made by welding half-section spirals to side rods to form a single grid unit. Grids are vital tube electrodes. The number of turns and the pitch of their windings must satisfy rigid geometrical requirements. These characteristics vary with individual tube types. Once adjusted for a

particular grid construction, this machine turns out highly accurate grid coils.

The lathes formerly used fabricated the grids continuously in short strips. It was necessary to heat and stretch the side rods, cut the strips apart, and remove the excess turns of wire between each grid. The new machine simplifies these operations and, in addition, avoids the wire waste inherent in the older, slower, less efficient production method.

The new machine makes grids by welding formed wires to the side rods at a single operation. The welding operation is controlled by radio tube circuits to assure the exact amount of electric current for the exact time required to make perfect welds of all the grid wires to the side rods. Water-cooled electrodes perform the welding operation. A variable-speed motor is used to drive the machine so that it may be adjusted to the most efficient production speed for each grid type.

DOOR CONTROL

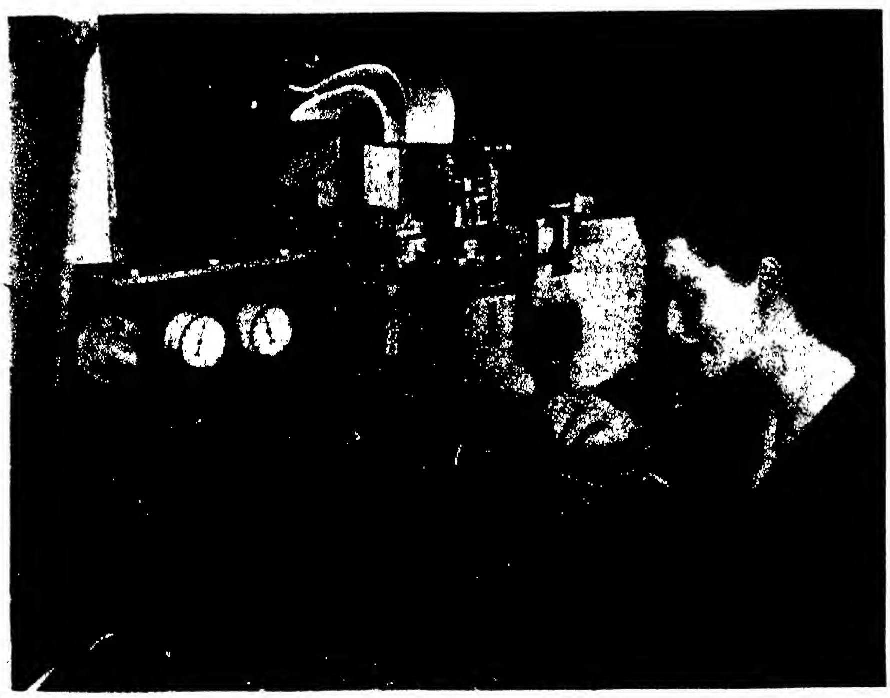
Photo-Electric Installation Saves Money

Savings as high as $30 per day in operating costs are claimed as the result of the recent installation of photo-electric control on the doors of the receiving and shipping department of the Brown and Williamson Tobacco Company. To this may be added substantial savings in heating costs as a result of having the doors automatically close after use.

Door-control equipment which saves heating and operating costs in a processing factory

With the shipping and receiving departments operating on a 24-hour-a-day basis, their six huge doors must be continually opening and closing to allow for the passage of incoming loads of leaf tobacco and outgoing shipments of cigarettes and smoking tobacco. These doors were previously operated manually at comparatively high cost, both in actual operating expense and in time lost in signalling for the doors to be opened.

The previous expense of heating these departments was also very high because the doors opened directly to the outer air and the slow manual operation of them allowed much heat to be lost. In fact, the doors were sometimes allowed to remain open continually, there being no time to operate them. These facts not only resulted in higher costs, but also made it difficult to maintain comfortable working temperatures for employees of the shipping department.



The machine that makes possible high-speed vacuum-tube manufacture

PURIFYING

Plastics Remove Impurities from Water, Other Solutions

Plastic resins, previously rated in terms of plastic properties and chemical inertness, are now being selected for physical rigidity and chemical activity.

It has been found that certain synthetic resins, such as those derived from phenol (carbolic acid) and formaldehyde, are capable of removing from water those ions which give rise to hardness, such as calcium, magnesium, and iron. The resins remove these undesirable ions by the process known as base exchange. That is, the sodium atoms associated with the resin lattice exchange themselves with the hardness-producing ions in the water, whereby the resin absorbs the calcium, magnesium, and iron, and the non-hardness producing ion goes into solution. This reaction is familiar in the zeolite process of water softening, which is employed industrially and in homes to soften hard water.

Just as in the zeolite process the mineral is revivified by the use of common salt, when exhausted, so the resin is reconditioned by a similar treatment. However, whereas the zeolite process was limited to waters which were essentially neutral in reaction (because the silicate lattice of the zeolite was itself disintegrated by the corrosive action of acidic or alkaline water) the stability and resistance of the new synthetic resin ion exchangers permits their use in water of all kinds. The mechanical and thermal stability of the resins is such that they may be employed at temperatures near the boiling point of water, as in the purification of hot solutions, without loss of capacity or efficiency.

Heretofore, natural and artificial silicates have been used in most water-purification equipment and while these inorganic materials are useful for "softening" water, they tend to increase its alkalinity and become saturated quite rapidly. Special resins of the phenol-formaldehyde type, on the other hand, can be tailor-made in order to remove selected impurities, have a

greater purifying capacity, and resist breakdown under the corrosive elements in the average water supply.

CORK

American-Produced Bark Holds Promise

CORK obtained from cork oak trees growing in California has proved under laboratory tests to be as good as, if not superior to, the imported product. This announcement was recently made by Dr. Giles B. Cooke, of the research staff of the Crown Cork and Seal Company, in *Industrial and Engineering Chemistry*.

"Cork is obtained from Portugal, Spain, and the other countries that form the shores of the western Mediterranean, being indigenous to the soil and climate of this region," Dr. Cooke points out. "Since the days of Plutarch and Pliny the world's supply of raw corkwood has come from this limited area. However, it is possible, and now appears very probable, that before many years the United States, which consumes more corkwood than any other country, will produce its own cork requirements.

"Climate and soil are two important factors which have restricted the growing of cork to those countries where it is native. Fortunately, the soil and climate of many parts of California are very similar to those of Spain and Portugal. The rolling terrain of California's sheltered valleys provides excellent growing conditions for the cork oak."

The time required for cork trees to reach productive maturity has retarded efforts to grow cork in new places, Dr. Cooke explains. "The first stripping of the cork oak is made when the tree is about 20 years old and subsequent strippings follow at eight or ten year intervals.

"The first cork removed is known as virgin cork and is of inferior quality and suitable mainly for insulation purposes. Cork from the second stripping is also of a low grade and has limited uses. It is with the third stripping, when the tree is from 35 to 40 years old, that good cork of commerce is obtained. Cork trees usually live for about 150 years, although many trees have been found that were much older.

"From time to time efforts have been made by the Federal Government to establish the cork oak in the United States. As far back as 1858 cork acorns were obtained from Spain and distributed by the Patent Department (the Department of Agriculture was not established until 1862) for planting.

"Some cork trees were grown in Florida, Arizona, and California, but many of these died from storms or lack of care. Later, about 1880, another attempt was made to introduce the cork oak, and acorns were distributed to suitable places throughout California, Arizona, and certain of the southern states. Scattered cork oaks can be found which have survived from this planting.

"A large planting of cork acorns was made at Chico, California, in 1904. Many trees are living from this effort and the Chico grove today constitutes the largest single area of cork trees in the United States. Natural propagation and plantings by interested residents are responsible for an unknown number of cork oaks.

"The California cork trees which were recently stripped are of several ages. Some from the Chico grove were 35 years old and some were from the planting of 1858. Others were of ages between these extremes."

VACUUM CLEANER

May be Used for "Wet" or "Dry" Cleaning

A HEAVY-DUTY vacuum cleaner which is equally adaptable to wet or dry cleaning is equipped with a system of baffle plates and filters. The motor and mechanism are completely protected from moisture so that under no circumstances can the cleaning blast harm the mechanism.

Versatile vacuum cleaner

This high-powered vacuum cleaner, known as the Black and Decker No. 95 Vackar, has been designed both for automotive and industrial use. Power is supplied by a one-horsepower motor driving a three-stage centrifugal fan. The sealed vacuum pull is 65 inches, and the draw is 60 cubic feet of air per minute.

With both inlet and outlet hose connections, the device can be used either as a vacuum cleaner or a blower. A thorough filtering of air provides completely clean air for blowing operations.

The entire unit is self-contained, it rolls easily over rough floors on ball bearing casters, and the 15-foot flexible hose easily reaches out-of-the-way corners.

STOPS DRIP

Spray-on Compound for Metal Surfaces

A SPRAY-ON plastic compound, containing specially treated cork particles, is now available for eliminating condensation drip from ceilings, walls, pipes, cabinets, and other surfaces. This type of drip, caused by temperature variations which bring about condensation of atmospheric moisture, is frequently damaging to raw materials, food products, furniture, and so on. Hence it can, if permitted to continue unchecked and with no effort to reduce its undesirable effects, become a costly problem in many locations.

With the new compound, known as Insulmat No. 595, positive protection against drip may be had at reasonable cost. It is applied with air spray equipment to any metal surface, and is self-bonding, requiring no priming coat, adhesive, or supports. It is claimed that one coat, 1/8 inch thick, is sufficient to eliminate condensation drip completely. Tests made at Purdue University have shown that this material withstands intensive vibration, has ample adhesiveness for the purpose, is odorless, and forms a satisfactory protective coating.

Possible uses of Insulmat include applications in freight cars and cargo ships, in trucks and trailers, and in industrial plants on cold air-conditioning ducts, cold-water pipes, and so on.

INDUSTRIAL TRENDS

SOME CALL IT "STREAMLINED"

JUST what is this thing called "industrial designing?" To some it is what they please to call "streamlining," completely missing the point both of the procedure and of their own term. To others it may merely mean changing the design of a product—be it mousetrap or turbine, typewriter or welding machine—to make it more pleasing in appearance.

To those who have had experience with industrial design, even in the smallest degree but sufficient to grasp the fundamentals, it is a definite trend of modern industry toward a combination of principles, all of which add up to an ultimate product that does its job in a better manner, is easier or more economical to produce, has greater eye-appeal and sales-appeal, and that, in a word which has been badly abused, is functional in design. Thus we find that the subject becomes many-sided. While the original intent in industrial design may have been to beautify a product, it quickly was seen that there were more important things to be done by the application of intelligent thinking that went beyond an end product which merely served a specific purpose.

When an industrial designer tackles a job, he brings to it a knowledge that is usually far broader than that of the engineers who worked out the essential details of the original product. This knowledge, plus an active imagination and a freedom from the conventions of the past, enables him to see possibilities that those closer to the job have overlooked. All this, of course, is no reflection on the men whose work it is to search out fundamentals, to evolve new products, new engineering principles. As a matter of fact, until such groundwork has been accomplished, the industrial designer frequently has little or no work to do. It is after the need for a certain product has been determined, and methods have been found for filling that need, that he comes to bat to boost the score of the home team.

Although industrial design has invaded almost every field of endeavor, redesigning, functionally, a multitude of things from huge power-plants to safety pins, from high-powered tractors to fountain pens, there are certain basic principles of the art that must be kept in mind. These involve a thorough-going study of the product, its purpose, its market, and the methods by which it is produced.

As long as there is no competition in a certain market, a product that meets that market's demands will sell regardless. But let competition creep in—as it inevitably will—and things begin to happen. Assume, for example, that there is only one electric iron on the market. It does its job after a fashion, but about the only thing that it offers the purchaser is freedom from the necessity of heating a flat-iron on a stove. The iron will sell, of course, because of this one feature. But then comes competition. The newcomer's iron may be no better than the original but it, too, will sell because of the demand. Now the designer goes to work. Here is a proved product, a receptive market. How to improve the product, broaden the market? The original iron is made of many parts, riveted and bolted together. Study shows that many of these parts can be cast or otherwise produced in a single unit. Redesign of the heating element decreases current consumption, increases heat. A new handle can be produced in two machining operations instead of the six needed in the first design, and fits more comfortably to the hand that guides it. Thus, step by step, there comes from the designer's drawing board a new iron that offers new features and is low in cost. The ad writers call it "streamlined": the designer calls it "functional."

Oversimplified as is the foregoing fable of the electric iron that beat a path to the consumer's door, while the designer turned that path into a six-lane super-highway, it serves to stress the point that there is more to this infant part of our industrial system than meets the eye of the casual observer.

PLANES FOR JOHN Q. PUBLIC

NEWS of the day continues to center attention on the military aspects of aviation, overshadowing a trend of flying which, if present appearances do not deceive, is going to be the one thing that, more than anything else, will bolster up the aviation industry when military requirements start to fall off. This is the trend toward private flying. No attempt is going to be made in this column to predict skies darkened by millions of flivver planes; better minds than ours have done that periodically for many years, only to wish later that they had gone fishing instead of wandering in the green fields of prediction. When, however, such organizations as the Ford Motor Company and United Aircraft Corporation report that they are actively experimenting with low-priced, fool-proof planes, there appears to be ample basis for a sane mental excursion into the future.

The fact that only 6000 light-planes were produced during 1940 would seem to indicate that there is not much interest on the part of the public who buys motor cars by the millions. But the reasons for this small demand are the same as they have always been: present-day planes are still relatively difficult to fly; they are dangerous compared to automobiles; and there are a limited number of large landing fields.

Ford and United are both aiming to correct these shortcomings by experimenting with planes that can be operated out of small fields—backyards, if you want to stick your neck out that far in prediction. This means that the ultimate plane will be so designed as to be controllable at or very near zero speeds, a possibility with certain helicopter types, as has been amply demonstrated by Igor Sikorsky. Ford, also, is leaning toward plastic body construction and a high-powered, light-weight, inexpensive engine.

There can be no doubt that a market exists for safe planes which can be flown as easily as a motor car can be driven. The potential demand for greater speed in transportation and for freedom from the restrictions of travel on the ground means that a mass market awaits the practical, fool-proof plane. Whether that ultimate plane will be of the conventional type, a giro, a helicopter, or a combination of the best features of each is something that only the future can disclose. In the meantime, the work of Ford, United, and Sikorsky will bear watching.

— *The Editors*

Mud Huts to Skyscrapers

Archeology Shows that Many Modern Building Methods are Thousands of Years Old

NEILSON C. DEBEVOISE, Ph.D.
Research Associate, Oriental Institute, University of Chicago

FROM a reed and mud hut to a steel skyscraper may seem a far cry, but many of the basic principles still utilized by the building trades were known and used 5000 years ago in valleys of the Nile, the Tigris, and the Euphrates.

In Egypt, especially, we can trace the development of building construction with considerable accuracy. The men of the Old Stone Age, the earliest inhabitants, enjoyed a more favorable climate than their European contemporaries. While the latter were driven into caves by the cold and glaciers, man in Egypt roamed the vast forests then covering the present-day Libyan desert and the Sahara. Toward the close of the Old Stone Age these forests began to disappear as the climate became drier, and man was crowded toward his dwindling water supplies. With his movements thus limited, he soon began to erect screens of wattle plastered with mud, then small huts of the same materials. In the New Stone Age, groups of such dwellings formed the beginnings of village life. From such huts soon developed reed, mud, and timber buildings, for by that time commerce was expanding and cedar was imported from Syria. Not long after 3000 B.C. these reed, mud, and timber structures were translated into stone, and many structural details of the early temples reflect forms occasioned by these earlier materials. Flint drills, copper, and, later, bronze chisels, were used. After 1500 B.C. iron might be employed.

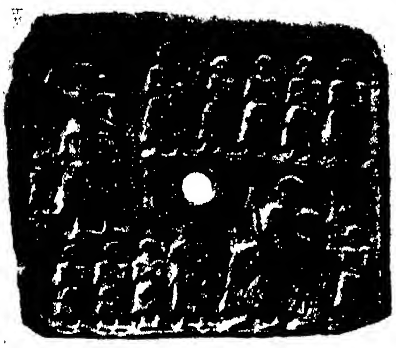


Figure 1: **A Chaldean king, in 2700 B.C., starts a temple job**

In Egypt and Mesopotamia men in antiquity did as they do there today—either built their homes themselves, or employed a local mason under a written and witnessed contract to work with them. Occasionally the builder agreed to furnish labor and materials, in return for which he might use the house rent-free for ten years. For everyone's convenience, building was usually done when farm work was at a minimum.

STRUCTURES under royal control were built by royal or temple slaves under experts in the king's employ. In Mesopotamia, where land-holders owed labor to the king, they might be called upon to help. The king, theoretically, took part in temple construction and, while he probably did no actual work, he ceremonially turned the first shovelful of dirt and carried it on his head in a basket (Figure 1). Current newspapers often contain photographs of some corporation head at the controls of a steam shovel turning the first ground for a new plant.

Another interesting modern parallel is the foundation deposit (Figure 2), now continued as the corner stone deposit. Originally a sacrifice of propitiation to the gods, by the first millennium the foundation deposit had lost its magical character and had much the same significance as it does today. Construction records were written on clay or metal tablets and buried under the corners of new structures.

Building materials were limited in those parts of the Near East where there was little timber or stone. Sun-dried mud brick has always been the most common building material in the Near East. With clay available everywhere and cheap labor in abundance, mud brick was utilized for every structure, except where the utmost in permanence was desired or where moisture made stone or brick imperative. Sun-dried mud brick possessed sufficient strength so that barrel vaults and arches 25 to 35 feet in span could be constructed. Some such 2000-year-old brick showed an average compressive strength of 123 pounds per square inch.

By 2700 B.C. simple bonding was used and occasionally what is now known as English bond was employed. Simultaneously, woven reed matting began to be laid between every three to five courses of brick to tie the wall together. In Egypt, where excellent stone was available, only the great temples, heavily endowed by wealthy and pious Pharaohs, were built of that material. Individuals, and even the Pharaoh, himself, had to be content with a mud brick dwelling which frequent replasterings scarcely kept habitable for more than three generations. In alluvial Mesopotamia even the temples were of mud brick. Burned brick, which in Persian times cost the equivalent of a bushel and a half of grain for 60, were generally employed only where water, as in drains and baths, made their use imperative. Not until the 7th Century B.C. were they used extensively even for palaces and temples. In Syria and Palestine stone often took the place of burned brick and it was employed in private houses as well as more important structures.

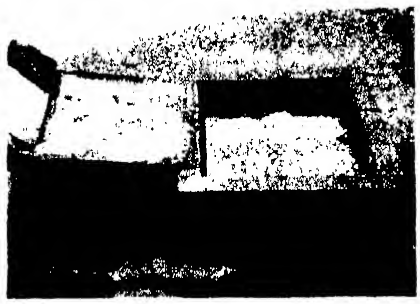


Figure 2: **Gold-silver tablets of a foundation deposit, Persepolis**

From very early times bitumen was used as water-proofing in drains and baths, originally over mud brick and later over the baked variety. Bitumen springs and oil seepages in northern Iraq fur-

nished waterproofing which was cheaply transported southward by river. By the 7th Century B.C., especially under Nebuchadnezzar of Bible fame, much brick work was laid in bitumen mortar, which gave exceedingly strong and durable walls.

Throughout the Near East, timber, especially in the larger sizes, was scarce. Syria, with its Lebanese cedar and Aleppo pine, and the mountains of northern India, were the main sources of supply. The Persian kings brought wood, probably teak, from India for their palaces. Transporting timber 12 inches square by 30 feet in length over a thousand miles of sea or mountains and desert would even today be a considerable task. Nevertheless inscriptions and architectural remains, as well as charred cedar, prove that the work was accomplished.

Both the peoples of Egypt and Mesopotamia prepared plans (Figure 3) for their more elaborate structures. Much of the detail was traditional and was not shown. Plans were often unnecessary since temples and palaces were frequently built upon foundations of earlier and similar structures. Egyptian plans, drawn in ink on papyrus or a smooth piece of limestone, sometimes showed both front and side views, although commonly only a ground plan was given. In both Babylonia and Egypt dimensions are sometimes given; frequently they are omitted entirely and we may suppose that the plan was laid out with peg and cord at the builder's instruction.

The tools employed by the ancients were of the simplest kind. With the aid of rollers, sledges, and levers the Egyptians handled stones weighing upwards of 1000 tons. In both Egypt and Mesopotamia a plumb-bob similar to modern ones was employed. In constructing Egyptian buildings the interior was filled with dirt as the work progressed, and ramps were built against the exterior. Up these ramps the blocks for the walls were moved on rollers or sledges. When the building was complete, the stone face was dressed, the work progressing from top to bottom as the dirt was removed. Scaffolding was employed and was probably used in cutting the reliefs. The pulley remained unknown until about the 6th Century B.C. and the simple tools enumerated above, plus unlimited man power, account for the great buildings of Egypt. The overseer of an expedition sent to secure building stone from quarries 87 miles away for a great temple in Thebes engaged 3000 men and 44 ships for the task. Building problems were

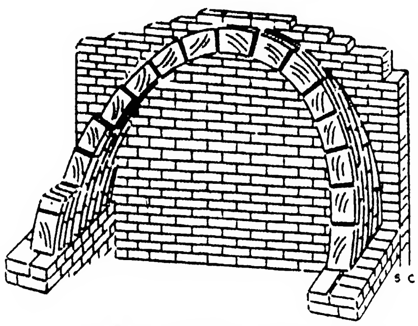


Figure 4: **A brick arch erected without centering. Early Egypt**

much simpler elsewhere in the Near East where stone of smaller sizes or mud brick were used.

A number of methods of roofing were available. The large monolithic block construction of Egyptian temples precluded the use of the arch in such structures and flat stone roofs were generally used. Indeed, the flat roof has been the commonest type in the Near East from the earliest times to the present day. Houses of mud brick use a flat roof of mud, the weight of which is carried on stout poles three inches in diameter. Over these is laid a layer of smaller poles and then brush or reed matting,

Figure 3: **At left, the plan of a Chaldean building, carved in stone, 2350 B.C., and, at right, another plan inscribed in clay, 2500 B.C. From Iraq**

Figure 5: **Mud brick arch of a private house, Iraq, 2700 B.C.**

topped off with six inches of mud, well packed with a stone roller. The mud provides good insulation from the scorching sun but the brush harbors scorpions, snakes, and rats, which sometimes lose their footing, much to the discomfiture of the inhabitants, as any excavator can testify.

The principle of the arch was utilized in Egypt from very early times. From 2700 B.C., and continuously thereafter, arches of mud brick were built in the Nile valley. These were commonly erected without centering, by leaning the entire arch against a thick rear wall (Figure 4). Occasionally centering, consisting of rings of specially made and shaped bricks, was constructed and the remainder of the arch built upon these. By the 12th Century B.C. barrel vaults in buildings were sometimes erected with the aid of forms, which in some cases were not removed but were left to create a ceiling for the room.

But earlier and more frequent in Egypt than the true arch was the false, or corbelled arch, found there as early as 3000 B.C. and commonly employed thereafter. All stone arches were of this type until the 18th Century B.C., when true arches were also made of that material.

About the same time that the true arch appears in Egypt, the barrel vault, the dome, and the arch appear in Mesopotamia. Apparently the dome and barrel vault were used above ground only at a relatively late date. Domed buildings appear on Assyrian reliefs of the 7th Century B.C., where towns of north Syria are pictured. Identical domed buildings are still used there today—the only place in the Near East where such roofs are

now to be found. While certain gateways of Assyrian structures of the 8th Century B.C. are roofed with barrel vaults, that form was not used to cover rooms until the beginning of the Christian era. The arch, however, was used above ground in Mesopotamia for doors, drains, kilns, and gateways continuously from about 2700 B.C. onward (Figure 5).

Barrel vaults, both with and without centering, were employed in sub-surface tombs at Ur of the Chaldees as early as 2700 B.C. and appear to have been commonly used after 2000. In the early examples the walls and perhaps also

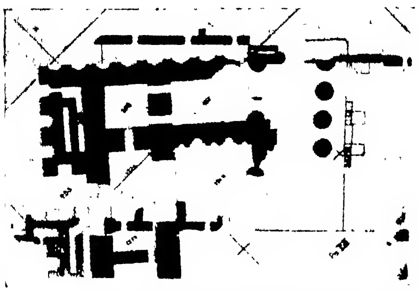


Figure 6: **Free-standing columns in plan of colonnaded building**

the vaults themselves were made by pouring a mixture of mud and stones over forms made of wooden planks. In some cases the stones were carefully laid, probably over good centering so as to form a true arch. The corbelled arch was also employed contemporaneously, the wishes of the builder or his skill seemingly determining the choice. Barrel vaults of burned brick were also built with the wedge-shaped bricks laid in an arch with radial joints.

Centering for such vaults was constructed on beams laid transversely and set into the stone walls at about the point where the arch began to spring. On these beams were laid planks, and upon the latter dirt and straw were piled to make a form. This method is employed in modern Palestine and probably elsewhere in the Near East today. Such forms were sometimes allowed to remain as ceilings to the chambers, as was done in Egypt.

That the column should appear at an early date is not surprising, for wooden poles were used from New Stone Age times onward as supports for house roofs. In southern Babylonia were discovered the remains of a temple with free standing columns eight feet in diameter (Figure 6). This building may be dated to about 3400 B.C. No other examples of columns are known until about 2700 B.C., although our information is not yet complete enough to assume that they did not persist in this interim. Most of the examples from 2700 and earlier, whether of brick or wood covered with shell inlay, appear to have had the palm trunk as prototypes.

How many of these architectural forms and building practices passed from Babylonia through the Mycenean world to Greece or spread northward into Asia Minor to be carried to Italy by the Etruscans is difficult to say. Perhaps some of the Greek mercenaries of Nebuchadnezzar, dazzled by the glories of the Ishtar Gate and the towering ziggurat (the tower of Babel) may have carried some of the tricks of the builder's trade to their homeland. Good ideas traveled rapidly 3000 years ago, even as they do today, and the Greeks, and the Romans after them, partook of the culture of all the Mediterranean lands, just as they gave much to it.

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FOLSOM MAN

Relics of Earliest Man Establish Time Scale

As a result of his continued work at the famous Lindenmeier site in northern Colorado, where nomad bison hunters camped in the closing days of the last ice age, Dr. Frank H. H. Roberts, Jr., Smithsonian Institution archeologist, has worked out a key to the culture sequence in the earliest known period of human occupancy of North America.

The bison hunters were makers of the characteristic "Folsom point," supposedly a spear head, which has been found in other places associated with the remains of the mammoth, the native camel, and the prehistoric horse. At the Colorado camp the most numerous bones are those of an extinct species.

There are certain variations of the point type, however, which have been gathered over a wide area. In some respects these have appeared to archeologists more primitive than "Folsoms" and it has been argued that the latter developed out of them. If this were true, it would indicate that the makers of the variant styles preceded Folsom man himself.

Dr. Roberts hit upon a nicely stratified corner of the Lindenmeier site. At the uppermost level were variant types of projectile heads such as have been found hitherto scattered on the surface in Nebraska, western Oklahoma, and Texas. Below these, and separated from them by a deposit, the building up of which must have required several centuries, were scattered specimens of still another Folsom variant, also found in Nebraska, Kansas, the Texas Panhandle, and New Mexico. At a still lower level, separated from the second by deposits which must have required hundreds of years to accumulate, were typical Folsom points in association with quantities of bones of bison and other animals.

The picture, says Dr. Roberts, can be reconstructed roughly as follows:

First came Folsom man, himself, following the bison herds southward through the lush pastures which came into being along the edges of the retreating ice. For various reasons the Lindenmeier site was a good camp ground for these nomads. They returned summer after summer and apparently made it a headquarters. Then something happened and the hunting parties were ended. After a few centuries, during which winds and floods had covered up the Folsom campsite, came other hunters. They used the site not as a summer camp, but as a bivouac.

In the intervening centuries the characteristic projectile head had degenerated. It was made more hastily and simply. The new hunters may have belonged to a different group, but they had acquired some elements of the Folsom culture. Again something happened, perhaps a major climatic change, leading to a dispersal of the bison. Again the campsite lay vacant while wind-carried dust and flood-borne debris piled up over it. Then came new bison hunters, with a still different type of projectile point.

Henceforth, wherever these different types of points are found, they will indicate the relative age of the occupation. The rough time scale thus made possible may cover 1000 years or more of human occupancy in North America. The period was roughly from 10,000 to 15,000 years ago.

AMATEUR SCIENTISTS

WHILE there always have been amateur scientists, never in the whole history of science have there been so many of them as there are right now, and they are increasing. The professional scientist has long been aware of their existence and growing interest in science, but even he did not sense the extent of it until recently when the American Philosophical Society supervised a test census of laymen-scientist activities in and around one city community—Philadelphia—and published a directory of amateur scientist organizations there. The professionals expressed astonishment when as many as 287 groups of amateur scientists, representing 32,000 members, were discovered thriving in that one community.

The boundary that once rather sharply demarcated the professional from the amateur has been largely erased by the existence of borderline bodies such as the American Association of Variable Star Observers and the American Meteor Society, in which amateurs in their spare time perform professional work, and the British Astronomical Association in which professional astronomers participate as amateurs.

Similarly, in the Seismological Society of America, Eastern Section, there is a Committee on Amateur Seismology, the professional seeking through this committee to encourage amateurs to make seismographic instruments and get into the game in their spare time. In the Seismological Society one could build a bridge by steps all the way from the relative tyro to the full professional; from members who are merely intelligently interested to others, such as fire insurance men and municipal engineers, whose interest is more direct, and so on across the gap.

The membership of the Society for American Archeology is largely professional but not wholly so. A perusal of its quarterly publication, *American Antiquity*, reveals that it, too, is a common meeting ground on which "men of a feather," as one member puts it, may find one another even though they have never met. Members of this organization come from all walks of life—which reminds us that the article on "The Temple of the Effigy," an account of its author's participation in the excavation of an Ohio mound-builder temple, published in Scientific American last August, was by one of them. He is a postal deliverer, who for many years has made a serious study of American archeology and who can recite letter and book on the complex culture levels of pre-Columbian Indian civilizations. It is smug even to be surprised that this should be so; for the postal deliverer, but for some of the trivial accidents of circumstance which determine our lives, might easily have been a professional scientist, just as the professional scientist in slightly different circumstances might have been a postal deliverer. One of Britain's noted archeologists was a grocer, and another is a merchant tailor. Knighted archeologists come to visit him

Charles Amsden, vice-president of the Society for American Archeology, has told how a man, who went to Nevada for his health, started hunting Indian things as a pastime and became scientifically interested. Finding no local sources of data, he called with much humility at the Southwest Museum in Los Angeles to find out who was the real authority on his local region. After hearing him out, and knowing that no archeologist had investigated that particular area, the professional told him "*You* are"—which put

him in a fine dither! Re-oriented, no longer feeling so inferior and humble, he went back to dig in the earth and into scientific literature, joined the Society and is up to his ears in a hobby that helps science.

None of the scientific groups named above is fully professional, but just what does this mean? Mainly it means simply that the professional is a man who works at it all the time, and the amateur is one who works at it part of the time.

That ancient boundary fence surrounding the professional is down in a lot of places, and isn't being put up again.—A. G. I.

SWEDEN COMMENDS

IN SOLACING contrast to the sharp brusqueness that today is keeping international diplomatic relations on tenter-hooks is the courtly graciousness with which His Majesty, King Gustavus, V, of Sweden, recently honored Sylvester J. Liddy, former contributing editor of Scientific American.

Mr. Liddy, a member of the patent law firm of Munn, Liddy, Glaccum & Kane, of New York City, was knighted with the Order of Vasa, First Class, in recognition of what, in his capacity as Director and Honorary Counsel, have amounted to "extra-curricular" activities for the welfare of the Swedish Chamber of Commerce in the United States.

It is not the bestowal of this honor by a European nation in sincere acknowledgment of constructive services favorably furthering Swedish-American interests, and its acceptance by an American citizen, that alone makes this incident worthy of comment. Rather, it is a significant trend, indicating that, despite the ominus totalitarian shadows now falling across Sweden from all directions, the Swedish government has not lost sight or control of the constructive niceties that lead to broader, sounder, and more amicable trade relations. It is significant, too, that The Order of Vasa, instituted by Sweden's King Gustavus, III, on the day of his coronation in 1772, is an award of merit for services rendered to the national industries and manufactures, a civic attribute long held in high esteem by democratic peoples.

That Mr. Liddy has found it possible to devote time and energy toward betterment of Swedish-American relations is exceedingly commendable; that the administration of His Majesty, King Gustavus, V, has taken cognizance of the efforts of a representative of our American democracy is a gratifying omen. —*A. D. R., IV.*

The Shape of the Earth

New Determination of Its Polar Flattening, with a Saner Proposal for Submarines

HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

AN INGENUOUS student once wrote on his examination paper: "The Earth is a great ball, flattened at the ends." One was tempted to ask him: "Where *are* the ends of a ball?" — but his answer got a pretty good mark, since the Earth is really flattened at the ends — of its axis of rotation.

To find out just how much it is flattened is a harder job than might be supposed. We can not calculate it by theory, though we know that the flattening is caused by the centrifugal force arising from its rotation. If our planet was a homogeneous body, of uniform density in all its parts, the ellipticity of its figure would depend on the ratio of the measured force of gravity at the equator to the centrifugal force calculated from the length of the day and the Earth's radius. But to calculate the shape of the outside of the Earth, we must know the way in which the density increases toward the center, or, to be more precise, a certain averaged effect of this increase. It is obviously impossible to find this directly, so we must find the external ellipticity by observation — after which we will be the richer, not only by a datum necessary for any accurate mapping of the surface, but by knowledge of the deep interior.

There are several quite different ways in which the Earth's shape may be found. First, we may measure the length of a degree of latitude on the surface. The elliptical cross-section of the Earth by a meridian plane is most sharply curved at the equator, and least at the pole, and one has to go a smaller distance northward in the first case than in the second to shift the vertical by one degree. We can find the latitude of any place with great precision by a few nights' observations. To measure the distance between two stations is a surveyor's job, demanding a high degree of care and technical skill, but fully practicable though expensive. Of course our stations do not have to be exactly a degree apart, or just at the equator or the pole; these things are simple to allow for. But they do have to be *on land,* and with a land connection between them or, at least, one broken by no arm of the sea too wide for the surveyor to sight across.

THIS method, then, no matter how much time and money is spent on it, enables us to find the shape of the surface of the continents, but not of the oceans. What we get is not the form of the irregular land-surface, but of the surface which would be found if a "sea-level" tunnel could be bored through the continent from coast to coast at such a depth that the sea would fill it partly full all the way. Ordinary precise leveling gives us the height of the surface above the water in such an imaginary tunnel. But would there be anything queer about the shape of the level surface thus defined? In some cases there certainly would. Consider an island such as Puerto Rico rising out of very deep water on each side. The rock of the island is denser than the water of the sea. Hence at a point on the north shore there is an excess of attraction southward (compared to what there would be if the mountain was removed and the sea filled in) and the plumb-line is deflected southward, toward the land.

The opposite is the case on the south coast. Hence the water-level in our imaginary tunnel would rise inward from both ends, owing to the attraction of the island mass, and be higher in the middle than if the mountain were not there. The slope at each coast is about one foot in 7500; the island is 33 miles wide; hence the excess height in the middle (which is half as great as it would be if the two slopes were extended to meet in a point at the middle) is six feet. The slope must continue, gradually diminishing, in the open sea for miles off-shore, and sea-level on the coast of the island must be raised fully ten feet by its gravitational attraction.

In our hypothetical tunnel, the surface of the water is more curved than that of an undisturbed sea. If we should expand it by calculation into a sphere, we would get one 260 miles less in diameter than the actual Earth. This is an extreme case; no one would think of finding the size of our planet from so small a measured arc under such conditions of natural disturbance. But the attraction of the continents as a whole must pull the oceans toward them, and produce a similar, though not so spectacular, effect.

Determinations of the polar flattening, which depend on the difference of the curvature of the surface in different latitudes, will be affected by a larger percentage, and whether the result comes out too large or too small will depend on the topography of the regions surveyed.

When good maps are available, the direct attraction of the mountains, and so on, may be calculated and allowed for. But it is found that this over-corrects the observed effects — showing that, deep under the mountains, there is a deficiency of mass more or less completely balancing the excess above sea level, — with an opposite excess of mass in the layer below the sea-bottom.

This isostatic adjustment is, however, not complete, so that it is impossible to allow fully for the local attractions.

A second method of attack on the problem depends on measures of gravity. This is less at the equator than at the poles, both because centrifugal force counteracts a part of the Earth's attraction and because the attraction itself is less at the greater distance from the center. The theory of the change, though not simple, is well-known.

The acceleration of gravity at any given station may be measured with great accuracy by finding the time of oscillation of a pendulum. The apparatus is fairly portable and may be carried wherever a car can go — being brought back for checking at intervals to a standard station where gravity has been

precisely measured. Accurate time is necessary for comparison; but this can now be had by radio, all over the world.

Gravity stations may be set up anywhere on land — on isolated islands too — and no costly surveys are required to connect them. Still more important, gravity may now be measured at sea. The roll of an ordinary ship, even in smooth water, disturbs the motion of the pendulums hopelessly. But in a submarine submerged a hundred feet or so, the motion of the waves is hardly felt, except in bad weather.

The distinguished Dutch geodesist, Dr. Veining Meinesz, has developed a most ingenious apparatus, such that the small residual motions of the submarine do not vitiate the accuracy of its results, and has personally made long transoceanic voyages in submarines of the Netherlands Navy. Work in the Caribbean has been done in American submarines, in the Pacific by Japanese, and so on.

It should be possible, then, in quieter times than these, to extend a gravity survey all over the globe. Such a survey would not only determine the general shape of our planet — the polar flattening — but also the large-scale departures from the simple spheroidal form, such as may be caused by the attraction of the continents, and of differences in the character of the deeper crust under continents and oceans, and reveal whether there are any deeper-seated irregularities in density, as yet unknown.

Dr. Jeffreys, the leading authority on this matter, has just published a discussion of the existing material. The desired goal is not yet reached, owing mainly to the lack of observations in the South Pacific, and in southern latitudes generally. He remarks: "A series of observations in a submarine traveling from Adelaide to Cape Horn, up the coast of South America, and back to New Guinea, would give an improvement of the estimates far beyond what could be done using the best methods on present data."

Should a "good time coming" succeed to the present distress, the world's geodesists will protest against the destruction of all submarines. They will ask, at least, to keep a squadron of the best and most seaworthy in commission, and send them, loaded with pendulums instead of explosives, all over the Seven Seas. They will have plenty of work to keep them and their crews busy until they are retired for old age.

Measures of gravity are not immune to the effects of the attraction of mountains and their buried roots — indeed, they give some of the best information about the latter — but a world-wide set of them should afford a much more accurate determination of the shape of our planet than any surveys on land.

There are other ways of finding the Earth's ellipticity which escape altogether the difficulties due to local attraction, since they depend upon the gravitational attraction of the Earth, as a whole, for the Moon, or of the Sun and Moon upon it. The attraction of the latter upon the Earth's equatorial bulge influences its rotation, as a small disturbance influences a gyroscope, and causes the precession of the equinoxes. The annual rate of this slow shift of the Earth's axis is very accurately known, the disturbing forces can be calculated in terms of the ellipticity, and a very good determination of the figure of the Earth follows.

The attraction of the equatorial bulge upon the Moon — more accurately, the difference between the attraction of the actual, spheroidal planet and a sphere of equal mass — leads to certain changes in the Moon's motion. There is a change in the latitude, by 8″.3 in either direction, with a period of about a month, and slow cumulative effects on the motions of the node and perigee.

The periodic perturbation can be found, clear of complication, from a century and more of observation, which is long enough to get its effects disentangled from other changes of nearly the same period. The motions of the perigee and node are added to and, at first sight, swamped by the very much larger effects produced by the Sun's attraction. But Brown has calculated this influence of the Sun with a precision of one part in three or four millions, so that the outstanding differences are known to about 0.5 percent of their values. If they acted alone the perigee would revolve forward in 200,000 years, and the node backward in 210,000. From each of these three influences on the Moon, separately, the ellipticity of the Earth can be found. The motions of the perigee and node depend also on the figure of the Moon. Fortunately, certain other things do so too. Though the Moon rotates once a month, so that it keeps always the same face toward the Earth, its axis is inclined to the plane of its orbit, and shifts its position as the latter shifts. It can be shown that the amount of this inclination depends on the ellipticity of the cross-section of the Moon by a plane at right angles to the Earth; that is, of the edge of the visible disk (averaging out the mountains). The ellipticity of the equator can be found — less accurately, but well enough—from a minute physical libration, or "wobble" of the Moon's rotation. Both these quantities have been determined by observation.

Collecting the results from the motions of the Moon and those from gravity on the Earth, Jeffreys finds that they are all consistent and indicate that the ellipticity of the Earth is $1/297.05 \pm 0.38$; that is, that the polar diameter is shorter than the equatorial by this fraction of the latter.

From the constant of precession, de Sitter, some years ago, derived the ellipticity $1/296.75 \pm 0.10$.

The "probable errors" attributed to the denominators indicate that, owing to the small inevitable errors of observation, the main figure is as likely as not to be wrong by the stated amount. It is clear that the two quite independent determinations agree as well as could be expected. The difference is 1/1000 of the amount of the ellipticity — which corresponds to 1/1000 of the amount by which the polar diameter of the Earth is less than the equatorial. This is 26.7 miles, so that the difference of the two amounts to only 140 feet on the whole size of the Earth.

The Moon's equator comes out very nearly circular, with the diameter pointing toward the Earth a quarter of a mile longer than that at right angles to it. The polar diameter is shorter than the latter by a little more than a mile and a half.

These are the differences which would result if the mountains were smoothed into the depressions and the effects of internal differences of density evened out. The resulting surface would nowhere be as much as half a mile from a sphere of the same volume. The irregularities due to the lunar mountains are far greater.—*Princeton University Observatory, April 3, 1941.*

Mad Dog—Mad Man

Most Modern Treatment for Hydrophobia is the Easily Obtained Semple Treatment

CHARLES BARTON, M.D.
Assistant City Health Officer, Los Angeles

IT WAS Pasteur who first worked out a successful treatment for rabies, but within the past few years a more modern treatment, which differs somewhat from that of Pasteur and in several respects is even better, has come into use among physicians. This is the Semple treatment and if you are bitten by a mad dog or cat, or other mammal, your doctor probably will employ it.

Theoretically, therefore, all you need to know and do is what he tells you. Yet there is a great deal that the layman can learn about rabies and rabid dogs which may be to his advantage—especially if it results in his learning to detect and avoid the rabid dog and therefore not even have to consult the physician.

While the virus of rabies is carried in the saliva of the infected animal and is introduced under the skin of the bitten animal or person by the teeth, rabies is essentially a disease of the nervous system and brain. And the victim does not acquire the disease until the virus reaches the central nervous system. The time required for this depends upon the location of the bite. Naturally, it takes the virus much longer to travel up the nerves from, say, the ankle to the brain than it does from the face or ear. In a dog the first symptoms may appear, from ten days to two months or more after the infection. In man this may be from 12 days to three months or longer. It is during this incubation period that the Pasteur treatment, or the newer Semple treatment, is administered. Should there be too great a delay in beginning the treatment, however, and should the symptoms of rabies actually appear, then the human patient is certain to die within three to five days, seldom longer. The dog, on the other hand, will live for about four to eight days after rabies set in. And it is during this time, and not immediately after he has been bitten by another dog, that his saliva contains the deadly virus.

In a dog, rabies may appear in one of two forms, either as furious madness or as dumb madness.

In furious madness the disease goes through three stages. During the first period the dog becomes depressed. If he obeys his master at all he will do so sullenly. And there soon will be a loss of appetite. This melancholy stage may last for only a few hours, or it may endure for two days.

There follows next a period of irritation, this second stage usually lasting from three to four days. If the dog is caged, he will tear and chew at the bars, sometimes even breaking his teeth and fracturing his jaws. His eyes become unnaturally bright, there may be some evidence of saliva, and he may emit a peculiar, terrifying howl. If the dog is not confined, he may range many miles from home, biting and snapping at anything which appears before him—trees, posts, cattle, horses, human beings, corners of buildings, or automobile tires. The furiously mad dog either trots or has a slow, loping gait with head and tail drooping. He may run in a straight line, but usually weaves from side to side.


Photos by Bob Plunkett
Rabies (dumb type) just before the hind legs become paralyzed

Only when the disease develops into the third and last period, the paralytic stage, does the dog desist from his desire to roam. He becomes subdued and more sullen, and staggers if he attempts to walk. His lower jaw is paralyzed and hangs down, and his mouth may drip saliva. Death from paralysis or exhaustion soon follows.

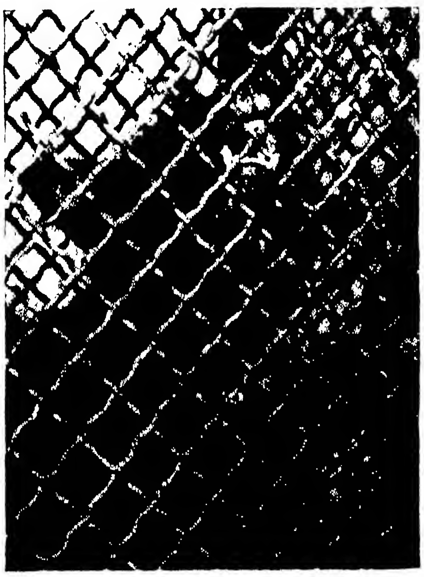
In the alternate form, or dumb madness, on the other hand, the second stage, in which the dog wanders over the countryside, may be lacking entirely, for the animal, with eyes that appear dull and glazed, becomes paralyzed in both hind legs.

But the most prominent feature, and the one that gives this form its name, is the dropped lower jaw, which becomes paralyzed to the extent that the dog cannot bite. Owing to a paralysis of the muscles in his throat and head, he continually scratches his throat, and this, combined with a hoarse, choking cough, may lead some good Samaritan to suspect the lodgment of a bone and innocently risk his life to set it free. The jaws are fixed, with the teeth separated, and the dog drools large amounts of thick, ropy saliva. It is this which accounts for the popular belief that mad dogs always foam at the mouth. Despite the fact that dogs with dumb rabies—the second form—cannot bite, they have a far greater flow of saliva than the furious ones that do the biting. And the saliva from this or from either type is liquid death if it gets through the skin.

THE symptoms of human rabies are very similar to those of animal rabies, and are equally terrifying. When the symptoms appear, a series of convulsions sets in. Between these convulsions the patient is entirely conscious and in terror of the next attack. The sufferer from rabies intensely *desires* water; he has no water "phobia," that is, fear. But he cannot swallow water—he cannot even go through the motions of swallowing. In fact, any attempt at swallowing may cause spasms of the throat and general convulsions. These may even follow the thought of swallowing, and this may account for the old notion that rabies sufferers fear water. There is also a secretion in the throat and mouth of a thick, viscid mucus, with a thickened saliva, and the effort to get rid of this, with the muscles refusing to act, causes the bark-like cough and

hawk. The temperature rises. The patient becomes maniacal. He dies.

It was not until 1885 that the first successful treatment for rabies, that by Louis Pasteur, was discovered. Pasteur experimented with rabbits, and he found that, upon being inoculated with an emulsion made from spinal cords taken from rabid animals, these rabbits became rabid, and died. If the spinal cords of these rabbits were inoculated, in turn, into a man, that man likewise would take rabies and suffer death. On the other hand, he discovered that if the rabbit cords were dried in the air, they would become less poisonous, and the longer they dried the weaker they became. Moreover, if a human being were inoculated from such a cord that had been dried sufficiently long, it would not give him rabies, for the agents, called antibodies, would develop and overcome the rabies virus. After this, if a cord that had been dried less than the first were introduced into the human being, more antibodies would develop,



Furious madness. The teeth are broken off on the wire screen

and these, plus the first ones, would destroy the virus of the second inoculation. Thus, with the daily inoculations from rabbit cords that had been dried less and less, and with the antibodies accumulating, the point would be reached where they would be sufficient to withstand the virus at its full strength.

While, briefly, that is the essence of the Pasteur treatment, of late a modification of it has been developed—the Semple treatment. In this the preparation from the cords of rabid rabbits is heated until the virus is killed and is therefore no longer capable of causing rabies, yet the killed virus retains the properties which enable it to produce the antibodies that destroy the virus from the bite of a rabid animal. Advantages of the Semple over the Pasteur treatment are:

First: In the Pasteur treatment the rabbit cords were hung over potassium hydroxide for from one to six days. Little chunks were cut from these cords, and the material was held in glycerine. When an order was received for the Pasteur treatment, which consisted of 21 daily doses, one section of cord was ground for each day's dose and mixed with additional glycerine and saline solution. In the Semple treatment, by contrast, the doses are all of the same make-up and size. In practice, the first seven are picked up at the drug store, and the remainder ordered and shipped in plenty of time. This, therefore, does away with the problem which the Pasteur treatment contained, in which each dose had to be shipped separately on consecutive days in thermos containers. Due to breakage of containers and the possibility of slip-up in the mail, every complete treatment consisted of a series of headaches for the laboratory and continuous anxiety for the patient and the physician.

Second: In the Semple treatment, relatively large doses are administered from the beginning, and this causes the patient to become immune more quickly than when the Pasteur treatment is used.

Third: Because the Semple treatment involves the use of killed virus, it can be discontinued at any stage if it is found that the biting animal was not rabid.

Fourth: In the Semple treatment there is no danger of the physician accidentally infecting himself.

Fifth: With killed virus, "treatment paralysis," which occasionally followed the use of Pasteur and other methods, has become almost non-existent.

Sixth: While with the Pasteur treatment the death rate was as low as 3 or 4 out of 1,000, it is even smaller with the Semple treatment.

If you are bitten by an animal suspected of being rabid, immediately get in touch with your physician or local health officer.

Don't kill the animal, but confine it within a safe enclosure, for it is

The beginning of another hideous convulsion. Patient is conscious, knows what's coming

much easier to determine whether or not it has rabies if it is alive.

Should the creature be rabid, it will exhibit the symptoms and die within a few days; if not, then the symptoms will be lacking and the animal will live. In the first case the doctor would continue his Semple treatment of the human patient who was bitten by the animal; in the latter instance he would be satisfied with merely cauterizing the wound.

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PREGNANCY TEST

Skin Reaction is Rapid, Reliable

A skin test which tells within less than an hour whether or not a woman is going to become a mother has been announced by Dr. Frederick H. Falls, Dr. V. C. Freda, and Dr. H. H. Cohen, of the University of Illinois College of Medicine.

The test is similar to those made for allergy to hayfever. It is said to be 98-percent reliable. Previously developed tests for early pregnancy take, according to reports of them, from 18 hours to two days. The widely used Ascheim-Zondek tests takes two days for a verdict.

In the test developed at the University of Illinois, colostrum is used. This is a watery liquid secreted in the breasts during pregnancy until milk formation starts after the baby is born. A tiny amount of this is injected by hypodermic needle into skin of the forearm. If the woman being tested is pregnant, there is no reaction. If she is not pregnant, a reddish area of one or two inches diameter ap-

pears within an hour around the injection point, disappearing within about five hours.

Besides the speed and economy of the new test, it is said to be valuable because it helps to differentiate between pregnancy and abdominal tumor and also helps to determine quickly the dangerous condition in which the baby starts developing outside the uterus of the mother.

Another rapid skin test for early pregnancy has previously been announced by Dr. G. C. Gilfillen and Dr. W. K. Gregg of Dayton, Ohio, reports *Science Service*. In this test a hormone is injected under the skin.

VITAMIN K

Medical Experiment Shows Value of Doisy Vitamin

Excessive bleeding of a newborn baby, due to injury, can be prevented by feeding the expectant mother synthetic vitamin K.

Experiments confirming this fact have been reported by Dr. James W. Mull, A. H. Bill, and Helen Skowronsko, of the research laboratory of the Maternity Hospital, in Cleveland.

Dr. Mull reported on experiments with one hundred mothers who were given synthetic vitamin K while they were in labor. Tests of the clotting capacity of the blood of the newborn child revealed a striking increase in the rapidity of clotting. Only one baby out of the hundred was found to have blood which did not respond to the treatment, Dr. Mull reported.

SLIT-LAMP

For Diagnosing Diseases of the Eye

In a manner similar to the way in which light, deflected and diffracted by dust particles in the path of a light beam, makes such particles appear self-luminous and larger than they actually are, so does a new slit-lamp illuminate the cell structures and minute opacities in the eye, affording the eye specialist greater facility in diagnosing pathological conditions.

Light from a strong nitrogen bulb source is condensed at a slit and this narrow beam is then projected into the eye. The cell structures and minute opacities can thus be observed and magnified by means of a wide-field binocular microscope. The three dimension view which is obtained in this manner makes it possible accurately to locate and measure the position of foreign objects in the eye, or the areas of disease. The slit-lamp,

Dr. Max Poser with the instrument, combining a new slit-lamp and a wide-field binocular microscope, used in diagnosing a wide variety of eye diseases

demonstrated recently by Dr. Max Poser of the staff of Bausch and Lomb Optical Company, may dictate the removal or the retention of an eye in cases of sympathetic ophthalmitis, in which the inflammation in a diseased eye affects the sight of the good eye. It will also provide information on the age of lesions and the nature of injuries or congenital processes.

THIAMINE

Way Found to Test Whether Body Lacks Vitamin

It is possible to determine whether a person's body is securing a sufficient amount of vitamin B_1 (thiamine) by determining the amount of the vitamin secreted in the person's urine.

This new clinical test for vitamin B_1 deficiency has been explained by Dr. Daniel Melnick and Dr. Henry Field, Jr., of the Department of Internal Medicine, University of Michigan. Dr. Melnick reported on experiments made with a group of adults known to be normal and another group known to be deficient in the vitamin.

The normal patients showed an average excretion of 12 percent of the original vitamin dose during a four-hour test period. The deficient patients showed an average excretion of 3 percent during the same period, the remainder of the vitamin having been absorbed by their bodies.

ACNE

Common Pimples of Adolescence Correlated with Sex Hormones

New evidence that acne, a skin eruption of the face and arms usually occurring during adolescence, is related to the sex hormones, was recently presented in a research report by Dr. James B. Hamilton, of the Department of Anatomy, Yale University School of Medicine. Although medical science has long known that such a correlation exists, no direct experimental evidence for it had been established.

Dr. Hamilton conducted his experiments with a group of men and women, all of whom were lacking in sex hormones. The group included male eunuchs (men who had either been castrated or who had not matured sexually), young boys who had not reached adolescence, and women who had lost their ovaries because of some disease or accident. None in the group had acne at the time the experiments began.

The patients were then given injections of male sex hormones (androgen). They immediately acquired the skin eruptions characteristic of acne. When the hormone injections were stopped, the skin eruptions rapidly disappeared.

"A close relationship of acne to male hormone substance is attested by the rapidity with which the acne fades upon cessation of the injections, and by the fact that a developing papule which has undergone retrogression may again become inflamed if treatment is resumed," Dr. Hamilton declared. He added that susceptibility to acne did not appear to be related to either the color of a person's hair or skin.

"The fact that sex hormones may induce acne in susceptible individuals is not proof that the sole cause of acne is the action of the hormone," he said. "Other factors and a predisposition to acne undoubtedly are of great importance."

Trucks for Defense

The Trucking Industry is Mobilizing its 4,500,000 Trucks for Emergency Transport

P. R. RIEBER

WHEN the German army began its major offensive at Verdun early in 1916, it had 14 railways at its disposal. The French had one. Otherwise, the defending forces were cut off from the rest of their country. One big push, lasting a few weeks, perhaps, the German strategists reasoned, and it would be all over. But they underestimated the resourcefulness of the French and they failed to take into consideration a new instrument of war—the motor truck.

Trucks received their baptism of fire on the 37-mile road from Bar le Duc to Verdun—the famous "Sacred Way"—and contributed much to the enforcement of the French battle cry, "They shall not pass!" Despite constant artillery fire, motor service on this shell-pocked lifeline was stepped up to the point where 1700 trucks passed each way daily, moving troops and artillery, evacuating the wounded, and furnishing food and supplies for 250,000 French soldiers. In his book on Verdun, Marshal Petain, the French general in charge of defense, states that during the two weeks from February 26 to March 16, 1917, the trucks moved 190,000 men, 25,000 tons of munitions, and 2500 tons of materiel.

• THE trucking industry of the United States is a service industry which transports goods by highway. It is composed of 4,500,000 trucks, operated by about 3,500,000 employees, and 1,000,000 farmers. Approximately 600,000 of these trucks are in the "for-hire" class; that is, their services are sold to shippers of goods. 1,000,000 are on farms. The remaining 2,900,000 are in the "private" class, owned and employed by individual businesses to distribute their own products. For the past two and one-half years members of this industry, through their national organization, American Trucking Associations, Inc., have been drafting defense plans for the use of their equipment in the event the United States enters the war, or should an even more critical emergency develop.—*The Editors.* •

The world knows the nation which best learned the lesson at Verdun. The "Blitzkrieg," product of the formidable Nazi Panzer divisions, is now an old story. The miracle of the German achievement in so speedily subjugating half of Europe lies in the service of supply. Without a constant stream of trucks loaded with gasoline, oil, rations, and other materials, the lightning conquests of the Panzer divisions would have been virtually impossible.

United States Army officials have marked well the success of the Nazi mechanized divisions. Here in this country they already have had a practical demonstration of the part that commercial motor vehicles can play in time of war. Early in 1940, for the first time, the job of furnishing supplies to a sizeable army was entrusted to commercial trucks at maneuvers in east Texas and western Louisiana. For more than a month and a half 30 trucks of the Red Ball Motor Freight Lines, of Dallas, were used exclusively to haul food, gasoline, and other supplies for two corps, known as the Third Army—a total of 70,000 men! The troops were concentrated near Sabine, Texas, for "war" between the Blue and Red Armies. Red Ball furnished trucks to the Red Army.

Their initial job was to equip the base depot with immediate supplies. This called for the movement of more than 30 carloads of non-perishable goods within a week, and supplies going to the depot, in turn, were transferred to various distribution points by truck caravan. Food alone accounted for a major proportion of the 500,000 pounds of supplies per day which left the base depot. Here are some of the supplies which were delivered daily: 12,000 loaves of bread; 100,000 pounds of ice; 15,000 pounds of fresh meat; 39,000 eggs; 3300 pounds of onions; 1800 pounds of bacon; 1300 pounds of lard substitute; 1200 cans of evaporated milk; 4800 pounds of sugar; 750 pounds of salt; 16,600 pounds of flour; and thousands of pounds of other foodstuffs.

Besides the rations, during the three-week period of maneuvers, 900 tons of hay were required; 1,500,000 pounds of oats; 61,000 pounds of bran; 200 cords of wood; 500,000 gallons of gasoline; and large quantities of oil, grease, gas masks, smokepots, ammunition, hospital equipment, radios, telephones, clothing, candy, veterinary supplies, motor parts. About 156,000 pounds of wire for the communication system also were hauled.

United States Army gave early recognition to truck transport possibilities

The trucks observed all Federal and State regulations, although they were under army rules, which in times of emergency presumably would supersede other regulations.

Inasmuch as most commercial vehicles operated by for-hire trucking companies are much larger than Army units, the Red Ball trucks had a distinct advantage. To supply a division of 8000 men, for example, three Red Ball semi-trailers, closed-van type, were needed; the same job would have required 24 average-size Army trucks. The result was definite economies, fewer drivers, less servicing, and savings in time. Officials of Red Ball and drivers were under direct control of the Army heads, drivers were selected according to their safety records, length of service, and citizenship, and every man cautioned against

talking about what he saw in the field. The commercial vehicles engaged in this operation were under constant surveillance and study by Army officials, including more than 70 generals from all parts of the country who witnessed the maneuvers.

General Joseph E. Barzynski, Chief of the Motor Transport Division of the Quartermaster Corps, recently stated that the army contemplates a total of 286,000 vehicles, necessary for a force of 1,400,000 men. Even cavalry mounts will be moved by truck. About 75,000 of the vehicles already have been obtained; by the latter part of April, approximately 140,000 will be in service; by June 30th, the figure will be around 190,000; and by late summer or early fall the Army expects to reach its goal of 286,000 vehicles. Insofar as possible, the War Department is seeking to standardize its vehicles by favoring ½-ton, 1½-ton, 2½-ton, 4-ton, and 6-ton chassis. Progress also has been made toward greater standardization, and interchangeability of parts.

Trucking companies and truck manufacturers, meanwhile, have been drafting their own defense plans for the past two and one-half years. Although truck manufacturers have assured defense chiefs that 1,000,000 trucks per year can be produced without straining capacity, truck operators have laid out blueprints for the use of their equipment in the event the United States enters the war, or should an even more critical emergency develop.

The United States is the most motorized nation on earth. Investments in the highway transportation industry, according to the National Resources Planning Board, total more than $19,000,000,000, as against $24,000,000,000 in the railroads and about $5,500,000,000 for waterways, pipelines, and airways. In 1939, the rails operated 246,922 miles of track; there were 3,065,000 miles of highways, 1,122,000 miles of which are now hard-surfaced.

How does the trucking industry propose to mesh these vast facilities of men and machines into the national defense program?

Two plans providing for the employment of existing trucking facilities, but insuring against any serious disruption of the normal services of highway carriers, have been placed in the hands of defense officials. The first merely covers co-operation of the trucking industry in the movement of defense goods; the second is designed to meet the heavier demands for transportation service which would develop if the United States actually entered the war.

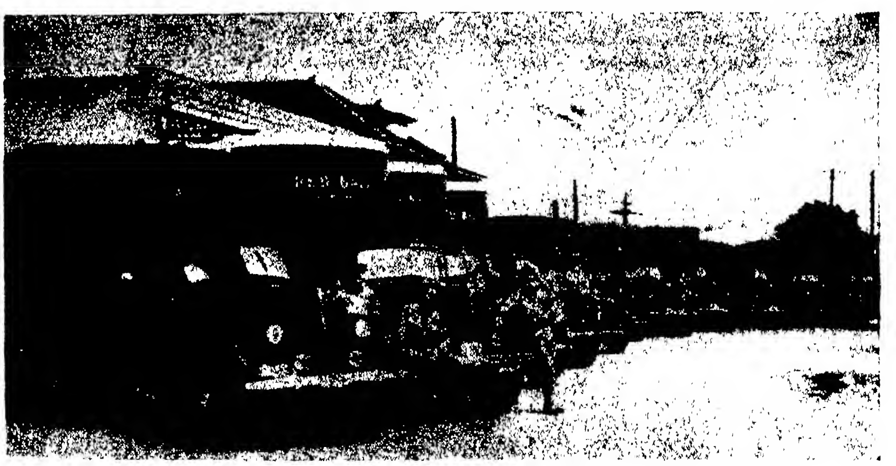
Plan One contemplates the establishment of a pool of trucking equipment, expanded and contracted from day to day to take care of fluctuating requirements. To avoid any congestion and delay, this program also proposes establishment of a central dispatching service to guarantee most efficient use of trucks and loading and unloading facilities. All operations other than dispatching would remain under the control of the owners and operators of the vehicles.

Requests for trucking facilities from the defense commission would go directly to the American Trucking Associations, Inc., with headquarters in Washington. This national organization, in turn, would telephone or telegraph the requirements to member trucking associations in the area affected. The state organizations, of which there is at least one in every state, would then relay the orders to the actual truck lines. Requests for equipment from the various corps areas would be made to the state liaison men, and relayed to the proper territory. Some idea of how the plan would operate comes from the Rhode Island trucking association, which states that within two hours it could muster 200 trucks for any service required. Truckmen in many states have had actual mobilization experience in disaster relief work, particularly in New England and the South, when they were struck by hurricanes and floods. This experience has proved invaluable in planning for defense.

Plan Two, for use in wartime, contemplates the use of the same basic set-up, plus the establishment of an "American Trucking Emergency Corporation" to handle the fluctuating pool of equipment. Thus, while in Plan One the national trucking association would direct operations of the pool in accordance with defense orders, under Plan Two an entirely separate organization would be set up. Equipment in the pool would be obtained not only from for-hire truck lines, but from owner-operators as well as farmer-operators. Many owner-operators are always available for over-flow work, and in the agricultural off-seasons farm trucks could be pressed into service. Vehicles of for-hire carriers whose customers are engaged in non-essential industries would be available, as well as the surplus equipment of other truck lines.

In drafting its plans, the organized trucking industry has borne in mind the fact that, in war time, operations on the home-front are as essential as front-line service. In other words, it has sought to formulate plans which will permit the normal services of the trucking industry to be carried on with a minimum of delay and interruptions. Suddenly to choke off peacetime highway transportation, the truckmen realize, would be as disastrous as failing to plan for the movement of men and materials.

If, after all surplus equipment has been thrown into the pool, there is still a shortage, then regular truck lines would make up the difference in the requirements on a pro rata basis. No line would have to endure any serious equipment shortage. Necessary data on



Trucks of "over-the-road haulers" blend easily into military tactics

Capacity of freight-hauling trucks makes army transport economical

equipment in the pool will be on hand in the offices of the various state trucking organizations. This would include information on the make or model of equipment; body type; capacity in pounds, cubic feet or, in the case of tank trucks, gallons.

Neatly dovetailing into these mobilization plans is a step which the United States Public Roads Administration is about to take. In co-operation with the states, the PRA will take an inventory of trucking equipment. The forms are now being printed and will be distributed during the month of June. Once the inventory has been completed, defense officials will know how many and what kind of trucks can be counted on if an overnight emergency should develop. Thus, if the Army needed a specified number of five-ton trucks for a certain period, it could determine where such vehicles might be withdrawn with a minimum interference with regular traffic.

ANOTHER important phase of truck mobilization deals with servicing of equipment. Arrangements have been made with the automobile manufacturers to keep the Emergency Corporation informed as to the availability of servicing facilities and replacement parts in the various corps areas. In this manner vehicles will be transferred only to those areas where there are adequate servicing facilities. The Emergency Corporation would be dissolved nine months after the emergency is over, thereby allowing ample time for terminating its affairs.

With the growth of the trucking industry after World War I, mileage of hard-surfaced roads in the United States increased from 360,000 in 1920 to 1,122,000 today. The War Department has laid out a network of 75,000 miles of strategic roads to be brought up to defense standards. For example, about 1800 bridges in the rural network of highways need strengthening so that they will be able safely to carry military and commercial loads dictated by emergency requirements. Even more urgent than this program, according to Federal road officials, is the need for construction of access roads and streets for new plants and Army cantonments. Access-road improvements which are required total 2900 miles alone, according to preliminary estimates.

There is only one dark spot in this whole picture of men and trucks for defense—the interstate trade barriers. Recently, there has been much evidence of the fact that the Army, as well as numerous other governmental departments, is fully aware of the problem. They have lined up in the fight against state trade walls which are obstructing the flow of defense goods. An uncompleted survey by the Federal Government already has uncovered 300 such statutes.

With the President calling on the whole nation to convert itself into an "arsenal for democracy," the load on all the transportation facilities of the nation is mounting steadily—and rapidly. The trucking industry's plans are laid and the wheels are rolling.

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BADGES

Identification Photos Taken Rapidly

NOW that national defense production has made necessary rapid and constant checking of the identification of factory employees, badges on which appear photographic likenesses of the wearers are being turned out by the thousands. One photographic set-up for this work, used by Westinghouse, is shown in one of our illustrations. The photographers work with assembly-line speed, averaging six pictures a minute. The camera used is a fixed-focus device through which feeds standard 35mm motion picture film from 100-foot rolls. It is claimed that one roll of film is sufficient for a full working day's production.

In many organizations where national defense materials are being produced, this identification system is being applied to all employees, from top executives to office boys. The pictures on the badges, sufficiently large to make possible immediate identification of the wearer, and available only to bona fide employees, will enable guards and watchmen to bar from the premises those individuals who have no legal right to be there. Simple precautions such as this can do much to prevent interference with the even tempo of defense preparations.

Photography plays its part in national defense: a moving picture camera being used to produce pictures that, printed on badges, will serve to identify workers in industrial plants

Bird Dogs of the Oil Field

Gamma Rays Often Point to the Presence of Oil in Old Worked-Out Wells

RANDALL WRIGHT, M.Sc.
Petroleum Geologist

AND now the petroleum geologist has appropriated the physicist's gamma-ray detector—essentially the same apparatus as is used by the astrophysicist for detecting cosmic rays—and applied it in the search for new oil-bearing rock strata. The usefulness of gamma rays to the petroleum engineer derives from their great penetrating power, which enables them to traverse steel or rock with ease.

The device used to detect these gamma-ray emanations from rocks consists of a cylindrical electrode surrounding and insulated from a single wire. These two electrodes are enclosed in a sealed glass container filled with air or some other easily ionizable gas, and a high potential is connected across the chamber from the wire to the cylinder. As long as nothing disturbs the gas in the chamber, no current flows. If, now, a gamma ray enters the chamber, the gas is ionized and carries the current from one electrode to the other. This current may be amplified and recorded. This is the physicist's gamma-ray counter—the Geiger-Müller counter.

The utility of this device for the oil engineer lies in the fact that various kinds of rock contain different amounts of radioactive matter, and therefore some rock strata emit more gamma rays than others. Rocks formed by the solidification of once-molten material—the igneous rocks—contain a great deal of radium and thorium, also their radioactive cousins. These igneous rocks, like the granites, were the chief source of the more widely distributed sedimentary rocks and it is in these sedimentary rocks that we find oil in paying quantities. They consist chiefly of shales which were originally muds, and sandstones which were originally sands. They were made millions of years ago by the processes of erosion and deposition. Stream-cutting and frost action and similar natural agencies acted upon the ancient granite hills, and the rivers carried the resulting mud and sand to the oceans and there spread them over great areas of sea-bottom, where they hardened to become the shales and sandstones we know today. Often intercalated with these sand and shale beds are layers of limestone formed of lime precipitated from the sea.

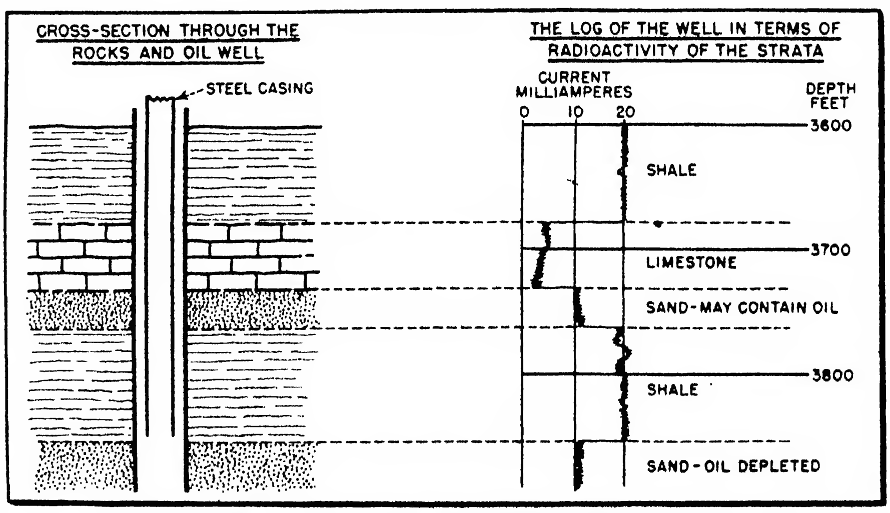
It is easy to see why the most radioactive of these sedimentary rocks are the shales, since they were formed as muds which contain much of the original parent-material of the ancient granites, brought almost unchanged from the lands to the sea-bottoms, for these granites included radium minerals. Sandstones, on the other hand, consist chiefly of quartz grains, which are not radioactive; waves and ocean currents removed most of the other minerals, including the radium-bearing compounds, before they were solidified. Since the radioactive minerals are present in sandstones only in minor amount, these strata are only slightly radioactive, and thus they affect the ionization chamber but slightly. The limestones, which contain no radioactive material, will, of course, have no effect upon the gamma ray recorder or counter.

These differentials of radioactivity exhibited by shales, sandstones, and limestones afford a readily applicable method of differentiating between them, and these differences are demonstrated when the ionization chamber previously described is lowered into an oil well. The flow of current, set off by the gamma rays, shows which is sand, which is shale, and which is limestone.

In practice, the device is placed in a metal case and lowered on a cable which also carries the necessary electrical connections. The record is made on a scale, reduced to convenient size, on photo-sensitive paper placed on a rotating drum synchronized with the reel carrying the steel cable.

The flow of current that is registered reflects the quantity of radioactive matter in each stratum passed by the device, and thus gives an index of its nature. Oil occurs most often in sands, sometimes in limestones and only under unusual conditions in shales, and this is the key to the method.

IN many cases in the early days of the oil boom, time was the valuable element, and the man who got his well drilled down first took all the oil under his own land and maybe a little from under his neighbors'; if he did not hurry, the neighbors got some of his oil. That system was picturesque, but lots of oil was missed—nobody knows exactly how much, but it was a great deal. The unscientific haste of such procedure means that many oil sands were drilled right through unnoticed. The well records, or logs, of those days were poorly kept or entirely neglected. In



How the ionization counter reads off the nature of the strata

these older, long-used wells, where the deeper sands have been depleted of their oil, there has until recently been no way of ascertaining the depth of the shallower oil sands, because the drill holes are lined with steel casings.

The ionization chamber, however, can "see" through this casing about as easily as though it were not there. The automatically recorded gamma-ray log made by this instrument shows the depth and thickness of each stratum. Such logs are being made today as part of routine operations in old, depleted fields. A truck backs up to the oil derrick and the ionization chamber is lowered into the well. The recording apparatus is in a light-proof compartment on the truck. The operation of lowering, recording, and raising again takes perhaps an hour. Then the petroleum engineer or geologist examines the record. If it shows a "sand" at a certain depth and the engineer believes it may contain oil, the casing is opened at this point by means of a knife-ripper, or a gun-perforator, or simply by a charge of nitro-glycerine. The oil flows into the well and an investment previously scheduled for abandonment is given a new lease on life.

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To Find $1000 . . .

A Pinhead-Sized Bit of Radium Can't Long Hide from a Physicist in a Ten-Acre Lot

R. BURTON ROSE, M.A.
Mining Geologist

One morning recently the "aristocrats" who spend much of their lives in the aromatic purlius of the city dump, mulling over the empty cans and bottles in expectation of finding riches, major or minor, were strangely perplexed. They apparently had competition. Three new scavengers were there, strangers and well dressed. They had a pick and a shovel and were using them in an awkward way; they also had some kind of box with a handle, that looked like a portable radio set. One of them wore a headset and wandered around in an odd manner. These certainly didn't belong to the social set of the "aristocrats," but just what was their odd game?

They were scientists, and they were looking for $1000.

That much worth of radium in seven tiny needles had been lost from a medical office a year previous. Thrown out by mistake with the trash, the needles went through an incinerator and were carried to the city garbage dump where a tractor stacked the refuse.

An electroscope search, in cooperation with the nearest college physics department, had proved unavailing and the metal-cased needles, far more valuable than their weight in gold, were given up as a total loss and insurance claims paid.

A geologist and his radio technician associates heard of the incident months later, and this led to research and development of the radium finder mentioned above. The unit is built around a counter tube sufficiently sensitive to detect gamma rays. Indications of the nearness of the radioactive materials come as increasingly frequent clicks in the earphones or the miniature loudspeaker.

Essentially, the instrument consists of an all-battery-powered, vacuum tube circuit giving an output of over 800 volts, which is impressed on the cylindrical anode of an ionization tube containing neon and oxygen gases. Each single gamma ray passing through the ionization tube causes a momentary discharge. The output from the cathode of this detector tube is highly amplified through an audio amplifier.

Armed with the detector, three searchers located and recovered all seven needles in less than a day's time.

The extreme sensitivity obtained is suggested by the fact that the total radium content of the needles found was only 35/1000 of a gram (small enough when pure to be lost on a pinhead), yet could be detected at several hundred feet. Subsequent experimentation has incorporated a recording counter, making possible exact quantitative measurements.

POLARIZER

And Now It's Down to Actual Molecules

A new kind of light polarizer which for the first time uses individual molecules instead of crystals as "combs" to line up the light vibrations is said to be the most efficient synthetic polarizer thus far produced. Made from coke, lime, air, water, and iodine, it is synthesized from materials which cannot be cut off in wartime. The new polarizer is the invention of Edwin H. Land, scientist-president of Polaroid Corporation.

Previous polarizers invented by Land and used in such applications as sun glasses and desk lamps have employed crystals embedded in a plastic sheet. The new H-type polarizer makes use of the molecules themselves to line up the light vibrations. It transmits one third more light than previous Land polarizers and it polarizes over 99.99 percent of all the light vibrations lying in the middle of the spectrum where the eye is most sensitive. Two sheets of it, with their "optical slots" turned at right angles, cut off the light and make invisible the rays from any ordinary light source.

One of the processes described in the patent for making the H-type polarizer calls for heating and stretching a sheet of solid polyvinyl alcohol until it is three to eight times its original length. This operation pulls the molecules of the plastic sheet into line. The sheet is then allowed to imbibe an iodine solution.

The high freedom from color of the H-type polarizer, together with its efficiency and polarizing power, are expected to make it suitable for scientific and military instruments, camera filters which will preserve the color values of color pictures, the projection of three dimensional pictures without color distortion, control of light intensity, devices for stress analysis in engineering and machine design, correct-color glareless illumination for desks, art galleries, and merchandise displays, and many other devices.

Tektites, Puzzle of Science

The Origin of these Odd Objects Remains a Mystery Despite Years of Dispute

JOHN DAVIS BUDDHUE

Many years ago the peasants of Bohemia noticed that their plows occasionally turned up curious pieces of rough green glass. The Vltava River flows through that region and so these specimens became known as Vltavines. Another name is moldavites.

The scientists of those days knew that Bohemia had long been famous for its glass, so they assumed that the pebbles were clinkers of ancient glass works. This satisfied some of them, but others were troubled because the pebbles were always green, and nearly always the same shade of green. Worse still, there were no other traces of glass works where they were found.

Geologists said that the deposits containing them were laid down long before man had learned how to make glass, consequently they were assumed to be obsidian.

In 1844, Charles Darwin published a description and drawing of a blackish-green pebble from Australia, and called it a volcanic bomb. Like the moldavites, it was regarded as obsidian, although no one thought of connecting the two then.

Still later, van Dijk found some oddly marked pebbles in the tin mines of the Billiton Islands, near Java. These were named billitonites, and were likened to moldavites. Meanwhile more of Darwin's bombs had been found, studied, and named australites.

An engineer named Bares attacked the still controversial problem of the moldavites, and proved conclusively that, whatever their origin, they were not artificial products, and had no connection with man-made glass, Bohemian or otherwise.

Later, surprised scientists read a paper by the famous geologist Suess, who claimed that these curiously marked glass pebbles were meteorites. Suess pointed out that moldavites are covered with a multitude of wrinkles, grooves, and pits, which he assumed could not have been formed by water, but which did have some resemblance to the markings of known meteorites. He also invented a new name for them, regardless of where they might come from. He called them "tektites," which means simply "melted."

Ever since that time a dispute has been going on among interested people. Some accept Suess' theory, and some say it is pure humbug; the remainder prefer to keep an open mind. If the problem could be settled by a vote, the meteorite, or "cosmic," theory probably would win, but in science truth cannot be attained by plebiscite; the minority may later prove to have been right.

Photos by the author

A moldavite from Bohemia. Note its oddly grooved markings

Meanwhile, more kinds of tektites were discovered in the Malay Peninsula, in Tasmania, and in British Borneo. Subsequent to Suess' cosmic theory, other variations were suggested, one being that tektites were volcanic bombs from the Moon.

De Boer discovered in 1829 that the then known tektite localities lay on or near a great circle around the Earth. This discovery led to the theory that the Earth once had a second and smaller satellite and that this had been broken up by tidal action. The tektites were thus supposed to be the fallen fragments.

More tektites were later discovered in the Philippine Islands. French Indo-china and southern China, the Ivory Coast of Africa, Java, the Libyan Desert, Sweden, and in Texas. Some of these discoveries did not fit the De Boer great circle but it has recently been shown that, by including the great meteorite craters of the Earth with the tektites, they all fall close to two great circles.

Under ordinary circumstances, when one finds a piece of glassy rock, such as obsidian, that is, volcanic glass, it is not difficult to account for its presence. Even when the obsidian is marked in a tektite-like manner, there are volcanoes not too far away. With tektites, however, it is another story. For illustration, by far the greater part of the tektite area of Australia is free of volcanic activity, and the same thing is true of most if not all of the other tektite areas. That is one of the best arguments in favor of the meteoritic theory.

Among tektites, the australites are a unique species: nothing like them is known anywhere else in the world. Dr. C. N. Fenner, an authority on australites, believes that they began as spheres of glass of various sizes which fell as meteorites. As they fell, the front side became highly heated and soon melted. The air rushing past swept the molten glass away to the edge, where it formed a rim. Thus the variety known as "blackfellow's buttons," or just plain "buttons," were formed. The forms are so perfect that it has been maintained at times that they must have been cast in molds. The "rim" of the "saucer" is fragile and easily broken away. There then remains a thin, lenticular mass of glass, a biconvex disk.

Some of the larger balls, under the Fenner theory, lost less of their mass in proportion and these landed in a form something like a scoop of ice-cream: a strong curve on one side and a gentler one on the other. These are known as "cores," or "bungs," if especially large. Some australites are oval but otherwise are like buttons or lenses, and these are known as "boats" or "canoes." Others are called "dumbbells," for obvious reasons. It is thought that these resulted from a mass of plastic glass rotating so fast that it began to fly apart, but cooled before the process was completed. In some cases, the glass actually did separate into two

parts, and gave rise to the "tear-drop" variety.

The surfaces of australites are generally rather smooth, but speckled with numerous tiny, shallow, round pits. Some have larger pits, and some of the bungs, at least, have clusters of grooves on their less curved sides.

Few moldavites have regular shapes, but there is a tendency toward spherical and ellipsoidal forms, and drop-shaped specimens are sometimes seen. Many are broken, and some of the fragments resemble the pieces of a large blister or bubble.

Although Suess seems to have been led to his cosmic, or meteoritic, theory by a fancied resemblance between the surface markings of moldavites and meteorites, later authorities have pointed out more than once that he was mistaken. Small meteorites rarely if ever have such markings, and, while large ones sometimes do, they are on a scale hundreds of times larger than moldavites. The markings of moldavites consist of rather deep grooves, often parallel or radiating. With these are fairly large and deep pits, and overlying both is a thick peppering of tiny round pits. Some authorities think the large pits are bubble cavities, and that

Typical moldavite, about 1 2/3 natural size. Habrd, Bohemia

the grooves are bubbles that were drawn out into tiny tunnels or tubes and then broken open. Others think that all the markings are due to corrosion of the glass. Between these extremes are those who believe that there is something to be said for both theories. The corrosionists have produced tektite-like markings on ordinary obsidian by attacking it with hydrofluoric acid and such experiments suggest that, over a period of hundreds of years, rather mild reagents might produce the same result as drastic ones accomplish in a few days. A piece of violet glass was found at Trebíc, Bohemia, which bore the same kind of markings as the Trebíc moldavites. This suggests that there is a substance in the soil of that locality which can corrode glass over a period of years. Further proof is given by outcrops of obsidian at Seleska, Slovakia, and at Hrafntinnuhryggur, Iceland, which bear markings strikingly like tektites, yet which have been acted upon by nothing more drastic than the weather in one case, and hot water, probably alkaline, in the other.

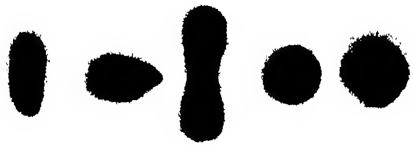
Of course, the experiments mentioned above have been made on artificial glass and ordinary obsidian, and it might be argued that the results cannot be applied to tektites which differ slightly in composition from most obsidians. However, moldavites on one hand, and indochinites, for example, on the other, differ far more in composition than either one does from obsidian, yet their markings are regarded as comparable.

Besides, proof that corrosion does have something to do with the moldavite markings can be found on the broken moldavites themselves. Some of the fractures are as bright and smooth as though made yesterday. Most of them are more or less dulled, and the duller they are the more they resemble the unbroken surfaces, until in the very oldest it is not always certain that a given surface has been broken. Moreover, this progressive change from fresh breaks to perfectly etched surfaces can be followed in indochinites, javites, australites, certain etched obsidians, and probably on other tektites as well.

Nevertheless, the bubble theory is not left without a leg to stand on. I have some indochinites that are as full of elongated bubbles as some kinds of stick candy. As one might expect, their external markings consist almost exclusively of parallel grooves. I have found something similar in a few moldavites; in these as well as Philippine tektites (rizalites or philippinites), I have found bubbles that are only partly broken open.

However, even if the question of the markings of tektites is ever finally settled as due to corrosion, or to bubbles, or both, the question of the origin of tektites will still be open and the debate will not stop.

There are extremists who insist that tektites are nothing more than an unusual variety of meteorites, and others who insist that they have nothing whatever to do with meteorites. There are also in-betweeners who have their own theories. Other theories are that they are volcanic bombs from the Moon, or that they are accumulations of the stuff from which comet tails are made. There are theories that they are the result of lightning flashes in dust storms, which



Australites. These are: boat, tear-drop, dumb-bell, lens, button.

fused some of the dust into glass. Another postulates a peculiar kind of meteorite composed of certain "light metals" which caught fire as it fell, and produced a glassy ash. This theory seems fairly good, except that such a meteorite would resemble known meteorites even less, if possible, than do tektites.

Another of the better theories is that of Dr. L. J. Spencer, noted British mineralogist, who suggests that they may be a by-product of the landing of very large, but otherwise quite ordinary meteorites. When a very large meteorite lands on the Earth, it may, and often does, strike so violently that the soil beneath it and parts of its own substance are fused, and even vaporized. Huge holes in the Earth associated with fused or altered rock or both, and often with meteoritic material, are known in Campo del Cielo, Argentina; Wabar, Arabia; Siberia; Canyon Diabolo, Arizona; Odessa, Texas, and Henbury, Australia. The fused rock is usually of a frothy, or pumaceous nature, and in some cases contains millions of minute beads of nickel-iron.

The theory of Dr. Carl Rufus, of the University of Michigan, is based upon a much older theory, originally having nothing to do with tektites, that the Moon once broke away from the Earth, leaving the Pacific basin to show where it had been. If this event took place, some fragments ought to have been left behind. Some of these might have had a period of rotation around the Earth coinciding with

the Earth's period of rotation, so that they would remain suspended over the Pacific basin. In time, gravitational attraction might cause some of them to fall. This would account for the uniform composition and great abundance of tektites in southeastern Asia, and the islands to the east, including Australia.

H. H. Nininger, of the Colorado Museum of Natural History, advances the theory that when meteorites bombard the Moon they send up violent splashes of lunar rock, some of it at such great velocity that it passes beyond the Moon's gravitational control and reaches the Earth.

The composition of the tektites is one of the strongest arguments against a meteoritic origin. Of known meteorites, some are composed of iron or a 50-50 mixture of iron and stone. These, of course, bear no resemblance to tektites, but the remaining meteorites are composed largely of stone. If fused and quickly cooled they would yield a dark-colored glass. This

A grooved moldavite from Habrí, Bohemia. About natural size

glass might bear some physical resemblance to tektites but it would be very different chemically. Roughly speaking, tektites contain 70 percent of silica; meteorites contain up to 55 percent of the same element. Darwin glass and the glass from the Libyan Desert contain about 90 percent.

To show how big a difference this really is, we refer to the petrographers, who have classified all rocks according to their chemical composition. Rocks rich in silica are near one extreme of the series, and those poor in silica near the other. Meteorites are classified among the ultrabasic rocks at the extreme low-silica end. Tektites, on the other hand, are among the most acid rocks, near the other end of the classification. Thus tektites and meteorites are about as different as silicate rocks can be.

Even if one overlooks this difference, no glass meteorites are known. Some contain a little glass, but one with even 10 percent of glass would be exceptional. Moreover, there is no way in which an originally crystalline meteorite could be fused to glass while falling. The surface melts, it is true, but, as fast as the material melts, it is swept away by the air as this rushes by. The fused layer on the surface of meteorites is rarely as much as a twenty-fifth of an inch thick.

Thus the mystery which began a century and a half ago is still without a definite answer. The origin of tektites is just as much a mystery as it ever was. As far as our knowledge goes now, the only way to prove a cosmic origin would be for someone to see a tektite fall, and recover it afterward.

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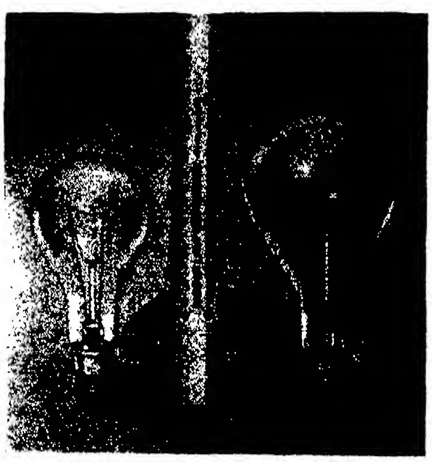
LAMP

Hard Glass Bulb Makes Possible Small Sizes

ATTEMPTS to reduce the size of high-wattage lamps have usually failed because the intense heat generated would melt the glass bulb or result in the collapse of the filament support. In a new type of high-wattage lamp, a hard glass bulb has been devised which overcomes former difficulties. This bulb, made by the Radiant Lamp Corporation, makes it possible to increase factory illumination 250 percent or more without changing fixtures. Because of the glass employed it is possible to reduce the size of a 500-watt lamp to that of an ordinary 200-watt lamp. The glass will also withstand thermal shocks of rain or sleet without



New and old—500 watts

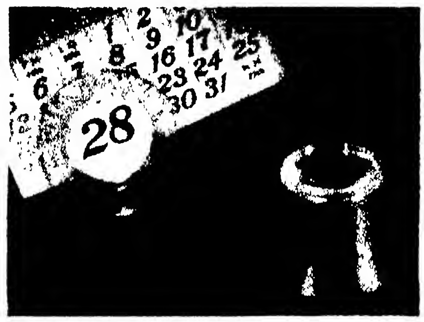
cracking, thus making it available for outdoor use without additional protection.

In place of the large "mogul" base of the ordinary 500-watt lamp, necessary to support the weight, this new high-wattage lamp makes use of the same size screw base as that used in an ordinary household fixture.

MAGNIFIER

Molded Plastic Makes Inexpensive Reading Glass

A SMALL magnifying glass, of the powerful jeweler's type, is now available in inexpensive form. Molded of Lustron, a water-white polystyrene plastic, the precisely curved lens is an integral part of



Of molded plastic

the flared base which keeps it always at the right distance. It is claimed that lenses made of this transparent plastic are practically flaw-free, assuring good magnification with a minimum of distortion. The ready moldability of the plastic makes possible high-speed, low-cost production.

BOOKS

Technical and Science Books Reach New Peak

BREAKING all quantity production records for the United States in scientific and technological books, publishers turned out 3,432,642 volumes in 1939, the Bureau of the Census has just reported.

This peak record represents an increase of more than a million books on science and technology over the previous manufacturers' census, of 1937. Added to these might be over 1,868,000 books on medicine, 1,018,000 books on agriculture, and many other books which overlap into the science and technology class.

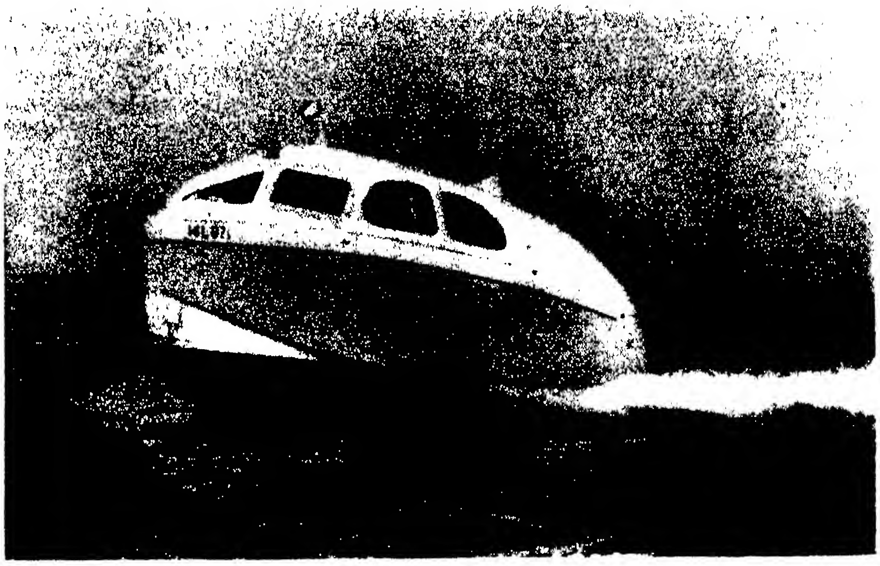
SPEED SHIP

Plywood Hull is Light, Strong, Fast

Modern plastics and radical airplane-type design are combined to produce a speedy carrier that is reported to cost less than three cents a mile to run and sells for as little as a thousand dollars. Designed and built by Arthur E. Doane, of Stamford, Connecticut, the contours of the ship are based on Boeing Clipper hull designs. The hull is made of plastic-bonded plywood with lightweight Plexiglas windows.

Because weight is the greatest single factor governing ship speeds, Designer Doane has pared every necessary pound from his cruiser. For example, weight savings were made by replacing 20 square feet of plate glass with a transparent plastic which is only half as heavy as glass. The plastic is tough, practically unbreakable, and unaffected by sun, wind, and sea water.

The resin-bonded plywood, also used in airplane construction, is stronger per pound than steel and cuts hull weight by a third. It is used in large sheets on the "stressed - skin" principle, thus making a single unit of the planking, ribs, keel, and deckhouse, and requiring only one fifth as many seams as conventional construction. Built-in spray deflectors, such as used on the new motor torpedo boats, and a "flying stern" that rides out of the water at high speed to permit level planing, are other features of the new craft.



Plywood speed ship on trial run, Long Island Sound

TREEOSCOPE

New Method to Estimate Health of Trees

Tree surgeons now have available an instrument that will do for them what the stethoscope does for the doctors who safeguard the health of humans—make a quick estimate of what's going on inside.

The new method is a result of the discovery, by Thaddeus Parr, of the United States Department of Agriculture, that there is a slight difference in electrical potential between top and root of a tree. During the time of fastest growth in spring, this gradient is from top to root; later, it reverses its direction. But in a tree seriously injured by insects or otherwise in bad health, the reaction is abnormal, being either weaker than a sound tree or reversed in direction.

A comparatively simple but very sensitive voltmeter has been developed that can be carried into the woods so that field diagnoses will be readily possible by foresters, entomologists, and others who have been trained in its use.

— *Science Service.*

SWALLOWED SHOT

Duck Deaths Prevented by Simple Device

Wild ducks are saved from death by lead poisoning with a device, invented by Warren H. Nord, of the Minnesota Agricultural Experiment Station, which works somewhat on the principle of the stomach pump used in human medicine, reports *Science Service.*

Wild ducks frequently shovel up shot pellets that have fallen into the water, in the course of their grubbing for food on the bottom. The pellets are retained in their gizzards like small stones, and in time may cause lead poisoning. Serious wildfowl losses have been traced to this cause in recent years.

Mr. Nord's lifesaver for sick ducks consists of two tubes of Pyrex glass, one within the other. For operation, the sick duck is laid on its back, with its wings and feet held to prevent it from struggling. The tube is carefully pushed down its esophagus and into the gizzard. A trickle of water is flowed through, in the annular space between the two tubes. This loosens the contents of the gizzard, which are then drawn out through the inner tube, by means of a slight vacuum produced by an aspirator attached to a laboratory faucet.

There is no difficulty in catching lead-poisoned ducks. They are just too sick to fly. The operation, of course, is not particularly relished by the ducks which naturally do not understand what is going on. But it does bring out the poisonous leaden pellets. And Mr. Nord figures it is better for the ducks to be uncomfortable for a few minutes than to be permanently dead.

RESERVOIRS

Life Shortened by Uncontrolled Erosion

Of the 12,000 or more water-supply reservoirs in the United States, over 20 percent have a useful life of less than 50 years, due to erosion of the surrounding countryside and consequent sedimentation. Another 25 percent of the total will be lost in 50 to 100 years, and only 54 percent will meet present requirements 100 years hence.

According to the Soil Conservation Service of the United States Department of Agriculture, erosion control practices have already proved effective in reducing reservoir sedimentation. A survey of the High Point, North Carolina, reservoir, for example, showed that erosion control had reduced the rate of siltation by 25 percent in less than 10 years.

NEVER SEEN BEFORE

Electron Microscope Reveals Viruses for First Time

DISCOVERIES in the realm of biochemistry which point the way to new frontiers in the field of medicine have been revealed by Dr. Thomas F. Anderson, RCA Fellow of the National Research Council. The methods used would be applicable in the study of such human ailments as smallpox, infantile paralysis, influenza, and the common cold.

Dr. Anderson pointed out that scientists are now able to see the larger molecules under the powerful magnification of the electron microscope. In fact, it is even possible to see reactions between individual molecules of different types. Such reactions are responsible for immunity to disease and even for the discomforts of ordinary allergies such as hay fever. Persons suffering from a disease develop antibodies in their blood streams, and these attack the disease agent, overcome the disease, and, in many cases, give the persons an immunity to the disease.

As a basis for their studies, Dr. Anderson and Dr. W. M. Stanley, of the Rockefeller Institute at Princeton, produced in rabbits an artificial immunity to tobacco mosaic virus. They actually succeeded in photographing the virus which had been attacked by antibodies from the rabbits' blood serum. The photographs were so clear that the actual manner and extent of attack could be determined. The techniques developed in these experiments are being used in the RCA Research Laboratories at Camden, New Jersey, as the basis for continuing studies of causal agents of human disease.

QUICKSAND

You're Safe In It If You Keep Quiet

IF you ever have the misfortune to fall into quicksand, don't get panicky and thrash around. If you keep quiet, allow yourself to go down feet first and keep your arms outstretched, you will soon find yourself resting at a depth just below your armpits.

This is the advice given by Lawrence Perez, director of the Soil Mechanics Laboratory at Cooper Union, in New York, according to *Science Service*. You stop sinking when your weight equals that of the quicksand you displace. As a matter of fact, quicksand will support you twice as easily as water.

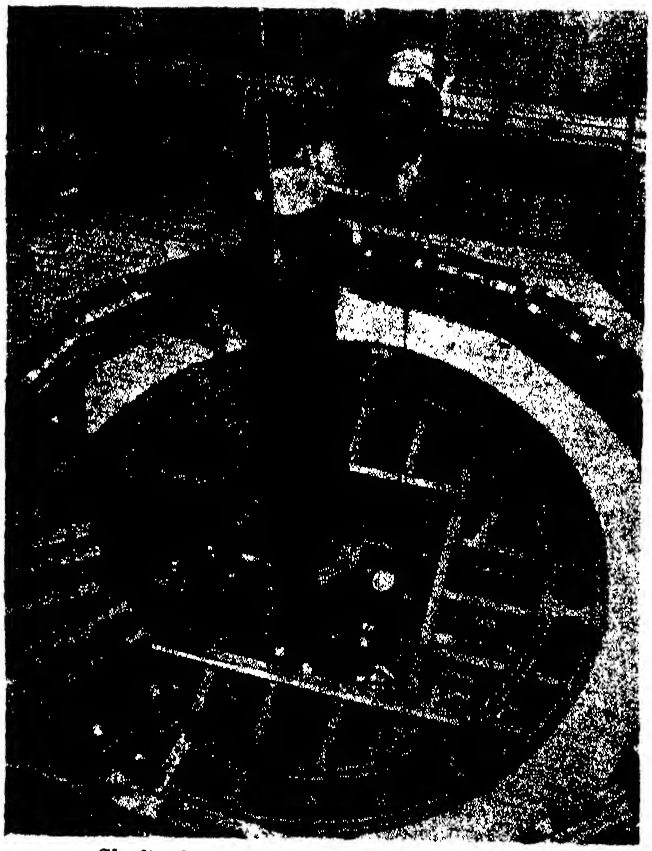
Quicksand is no particular type of material. Instead, it is a condition possible in granular soils where flowing water exists. The weight of the solid particles is balanced by the water pressure.

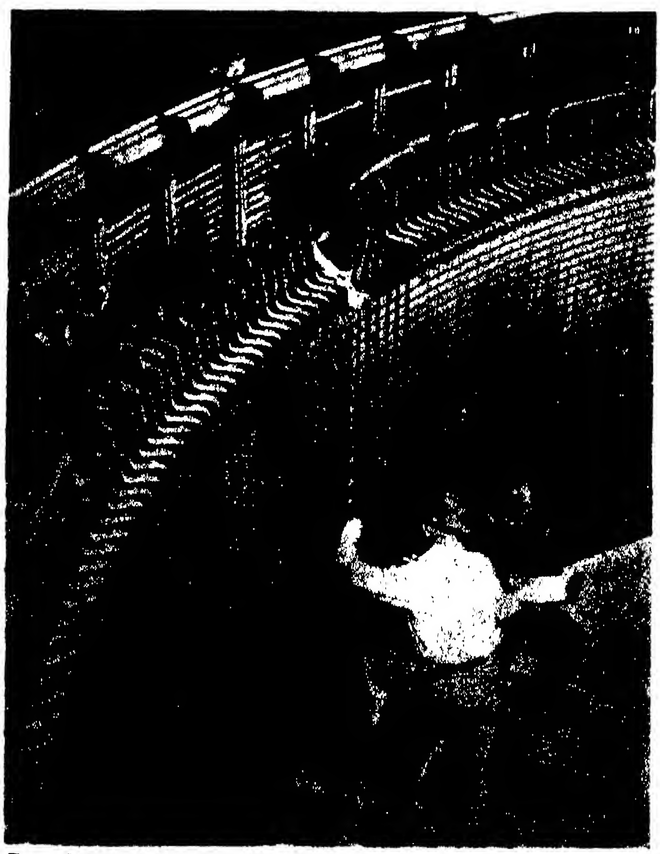
GENERATORS

Power Production Started at Grand Coulee

THE first two water-power turbine generators have begun their work at Grand Coulee Dam of turning the energy of falling water into electric power. These first two generators each produce 10,000 kilowatts of energy and are known as "station service" generators. For the present, and until the first main generating unit of Grand Coulee is placed in service, these two generators will supply power to a line connecting Grand Coulee Dam to Bonneville Dam, thus augmenting the power supplied by Bonneville for some of the vital defense industries of the northwest. Later, these two 10,000 kilowatt generators will be used for supplying power to the Grand Coulee powerhouse itself — for lighting and heating and for operating electric motors, air compressors, and numerous other station auxiliaries.

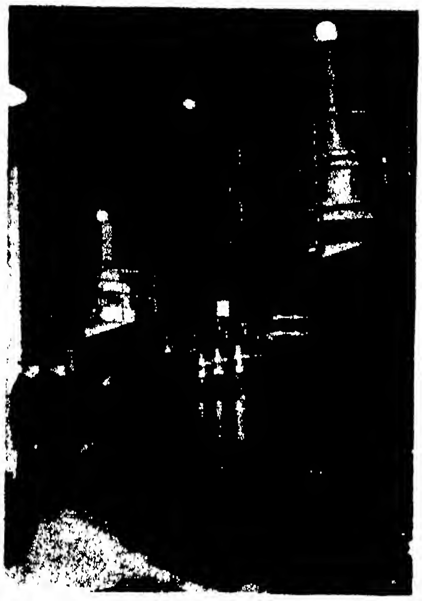
The main generators at Grand





Shaft of one of the 108,000-kilowatt generators for Grand Coulee, and checking generator stator joints

Coulee will completely dwarf the "station service" units. Each of them will have a power output of 108,000 kilowatts, the rotors being 30 feet in diameter at the largest section. Completely assembled, these generators will be 24 feet high and 44 feet in diameter and will contain more than 4,500,000 pounds of steel and almost 300



Station service generators

miles of copper wire. The rotors will rotate at a speed of 120 revolutions per minute.

When the Grand Coulee power plant is complete it will consist of 21 power generators. Three of them will be of 10,000 kilowatt size, while the remaining 18 will be rated 108,000 kilowatts. It is expected that three of the large machines will be in operation by next summer. One of them is now being assembled at the dam.

Energy from many of these units will help to lift water to the vast semi-arid Big Bend area and thus restore productivity to over 1,200,000 acres of land. In addition, these generators will make available a vast reservoir of power for national defense and peacetime industrial needs.

STABILIZING A DUNE

Planting of Pines to Protect a Harbor

With sand threatening to choke up their harbor, the people of Grand Haven, Michigan, are doing something about it. For years a huge dune has been showering tons of sand into the Grand River, necessitating frequent dredging by engineers. This year the citizens

of Grand Haven are determined to "tie down" Dewey Hill once and for all. The city acquired 83,000 pine trees, and one day the whole community marched on the hill, armed with shovels and buckets, to plant them. The volunteers, with the help of CCC workers, covered about 40 acres with the trees. It is expected that the pines, together with the beach grass planted by a CCC crew, will hold the sand in place and help protect the harbor. The planting is a part of the work of the West Ottawa soil conservation district, started in the Grand Haven area two years ago.

LIGHT METER

Extinction Type is Simple to Operate

IMPROPER lighting wherever artificial illumination is used—whether it be in home, office, or factory—is definitely known to cause irritableness and fatigue. Often insufficient lighting is a serious contributing factor to impaired eyesight, yet surveys show that many of us work and play under conditions of illumination that are seriously in need of correction.

Frequently the only correction necessary is the repositioning of a lamp or substitution of a bulb of

Using the light meter

higher wattage. The only way to be sure, however, that there is sufficient illumination for the work in hand, is to measure it.

This measurement of lighting can now be done rapidly and inexpensively with a new extinction-type light meter called the Lightmaster, developed by John A. English and Company. As our illustrations show, this meter is

easily read and checked against a chart which is an integral part of the meter itself. This chart covers the most common applications of lighting, while a more comprehen-

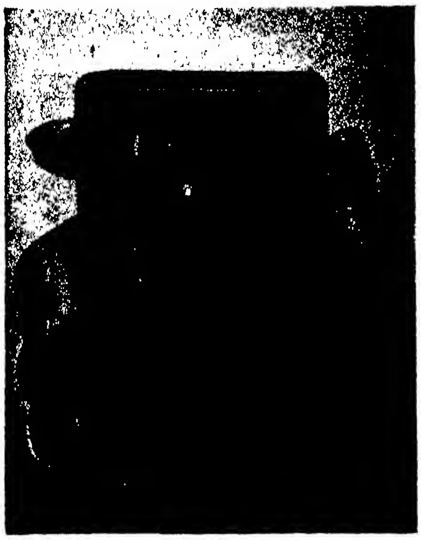


Chart is built in

sive listing which accompanies the meter goes into greater detail.

This extinction type light meter is completely free of complications so that even a school child can use and interpret it successfully. The case is made of durable plastic and metal with no moving parts.

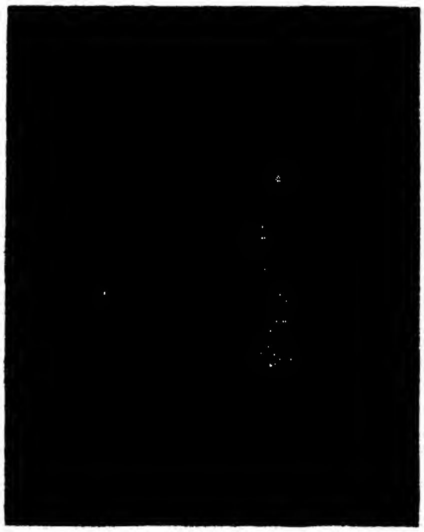
HOUSE NUMBERS

Visible at Night Under Ordinary Street Light

ADDRESS numbers which "shine in the dark" by reflection from ordinary street lighting in the usual village or suburban arrangement, are made of Lucite, a crystal-clear plastic which controls and reflects light without glare.

The numerals are made with a series of tiny parabolas or saucer shapes in relief pattern on the back of the plastic, backed with thin metal and outlined by a plain, transparent rim of Lucite. Each little saucer acts as a minute controller and reflector, not only shooting light back toward its source, but causing the whole numeral area to glow as though illuminated from behind.

Because Lucite has the property of internal reflection, light penetrates the flat part of each saucer shape but cannot penetrate the curved sides and so is concentrated within each tiny circular area. By thus preventing the light from spreading too much, glare elimination is accomplished. The saucers offer just enough



They "shine in the dark"

spreading, however, to provide the desirable wide angle of vision. The principle is the same as that used in lighthouses to attain the best balance between light control and a wide angle of vision.

Legibility of the numerals is further aided by the contrasting plain surfaced plastic rim outline. Daytime legibility is also excellent. There is no variance in legibility as each numeral, being molded, is a precision piece—an advantage of plastic materials. This method of mass production also makes possible extremely attractive cost.

BODY REBUILDING

New Molecules Replace Old Rapidly

It has often been said that the human body, undergoing continual change, is completely rebuilt with new molecules every seven years. Latest scientific evidence indicates that this complete regeneration of body substance takes place in much less than seven years.

Experiments with rabbits and rats which provided this evidence were reported by Dr. Rudolf Schoenheimer, assistant professor, Dr. Machael Heidelberger, Dr. D. Rittenberg, and Dr. S. Ratner, of the Department of Biochemistry, at Columbia University. Previous to these experiments scientists had believed that the protein substances of the body were much more permanent than other body substances, and that possibly they did not change at all. The research reported by Dr. Schoenheimer on chemical changes that occur in body proteins proves that the proteins are being replaced with new molecules continually and rapidly.

"Winged Warfare"

A Message to the Nation from Airmen Who Know What Military Aviation Needs

ALEXANDER KLEMIN
Aviation Editor, Scientific American.
In charge, Daniel Guggenheim School of Aeronautics, New York University

Our military airmen are not ordinarily loquacious; the task of interpreting the aviation needs of the Army is more apt to be undertaken by newspapermen and Congressmen than by Air Corps Chiefs. Therefore, when Major General H. H. Arnold, Chief of the Air Corps and Colonel Ira C. Eaker, of G.H.Q., Air Force, collaborate in writing a book entitled "Winged Warfare," the nation will do well to read — particularly today.

Profusely and well illustrated, written in sober, clear style, "Winged Warfare" postulates certain questions and answers them. How many airplanes do we need? What kind of planes shall we build? Can we catch up with Germany in the air armament race? Should we have a separate air force? Are our planes better than England's and Germany's? What is the plane-building capacity of our aeronautic industry? Can Mr. Ford build fighting planes? Why not train 50,000 pilots? On the correct answers to these questions depends the future of civilization. General Arnold and Colonel Eaker will readily admit that some of these questions can only be answered by time, that some of their answers have already been contradicted by events. But their splendid book divides the whole subject into ten logical divisions, and lays the foundation on which knowledge rests and hence decision may be based. The best plan for anyone who is interested in this topic (and who is not?) is to buy, borrow, or steal the book and read it; this review can only quote a few striking thoughts or facts.

Actual warfare is the best instructor and that is why British experience is worth millions, even billions, to us. Only after the campaign in Poland was it found necessary to have a "command plane," capable of landing in small fields or limited areas, and to permit the commander to look down on a battle scene. The authors are right; the command plane is invaluable. But why would not an autogiro or a helicopter be even better than a command plane?

Another lesson of warfare, drawn from the German campaigns in Norway and the Netherlands: we should have an airplane freight carrier for special supply purposes and for troop carrying. Here is a novel idea that General Arnold and Colonel Eaker approve; the glider train, and in particular a giant glider with sufficient size and carrying capacity to carry light tanks. "One particularly forward-looking inventor used the tank as the motive power to give the glider speed enough on the ground to take the air and thus to assist the towing airplane on the take-off."

A training plane in the early days was a very simple affair. Now a variety of training plane types are needed, and the twin-engine trainer has come to the front. Such a plane will be a measure of economy and efficiency in training personnel for multi-engine bomber operation. It will be a reasonably light, low-wing monoplane, with two engines of 300 to 400 horsepower each and an instrument panel closely resembling that of a medium-size bomber.

In an early chapter of the book we find the designation "Winged Warriors." How romantic, and how appropriate! Does West Point really teach its graduates how to write? "The boy in the Spitfire heads for the formation, singles out the left rear bomber, moves in behind, opens up at 100 yards with all his guns .... He knows the grim answer. As he flys over the enemy bomber, a bullet cuts a gas line .... The Spitfire is too fast to set down in a rough sea safely so he pulls back on the stick, rolls the plane on its back and tumbles head over heels through space. A pull on his parachute rip cord and he sits beneath a hugh, white canopy. He sees his stout little plane hit the water with a great splash and is glad that he is not aboard .... As

he tastes salt water and desperately fights his way from under the wet folds of his 'chute, he may reflect that life and death move swiftly in this air business."

We all of us know, or think we know, characteristics and qualifications of the military pilot. What of the bombardier whose problem is the laying of high explosives with accuracy on vital enemy objectives? "War has demonstrated time and time again that bombers who cannot hit their targets are of little more than a nuisance value in war. Bombing units must be able not only to find a target, but they must be able to hit it . . . . Physically and psychologically the bombardier must be of the same stern stuff as the combat crew members. It is probable that it is wise and well for him to be the most phlegmatic of the flying brotherhood. He generally has his back to the fight. It requires a stiff spine, knowing that a fighter is on the bomber's tail pouring bullets into it, to sit with eyes glued to the instruments, with back to the fray and observe the steady progress, the ticking of the second hand and the approach of the target. . . ." Courage still counts and billions will not supply its want. The authors also give unstinted and deserved praise to the Army Air Corps mechanics without whom there would be no air corps.

In the matter of air tactics, history has little to teach. That is why the Germans, who had no old Generals left over from the last war, did so well. They improved their air tactics and really used the airplane. Nevertheless there are some principles of air tactics which are already well standardized. "The offensive fighting spirit must be instilled in all crews. Shooting is more important than flying. Volume of fire at close range is what counts; long-range, hit-or-miss shooting is out, it wastes precious ammunition . . . . The picture of the attack must be brought back; it shows crews their deficiences . . . . The bomber must not turn and fight. His only objective is the destruction of assigned targets . . . ." Surely all our military officers could read these remarks with benefit.

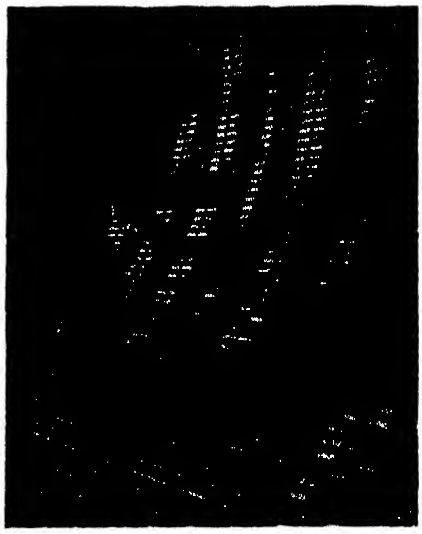
Air strategy and defense against air attack are treated with equal mastery. The chapter on Aircraft Production, if followed by the Air Corps in particular and the Federal Administration in general, would end all our troubles as regards procurement! The chapter "Air Force for Us" is equally wise.

Congratulations to "Happy" Arnold and his gifted associate. Every one interested in supporting the government of our country in its great task of today can learn from the fascinating pages of this book.

WIND TUNNEL

Fans Driven by 40,000 Horsepower Motor

The new wind tunnel at Wright Field, Dayton, Ohio, will be a closed, circular jet, varying in diameter from 45 feet to a minimum of 20 feet at the working or testing section. The air, as it passes round and round in the steel and concrete jet or channel, will reach its highest velocity at the narrowest section, where a hurricane of 400 miles an hour will be created and airplane models of 15-foot span will be tested for efficiency, stability, and control. The structure housing the tunnel will be 68 feet high, 108 feet long, and 62 feet wide. The models will be suspended in the test chamber by three struts connected to a balance, and the readings of the balance will be automatically recorded.



Working on the strator of the motor described in this column

Two 16-bladed giant fans, each measuring 40 feet in height, will pull the air through the tunnel. To drive these huge fans there will be needed 40,000 horsepower, supplied by a Westinghouse wound-rotor induction motor, the largest ever built. It is very important that the speed of the fans, and hence of the motor, be kept constant during an experiment. By a

system of two motor-generator sets, Westinghouse engineers have combined close speed control with little waste of energy. The 40,000 horsepower motor is gigantic and needs 85,000 cubic feet of air every minute just to cool it. Our photograph shows a Westinghouse craftsman fitting some of the windings in the stator of the record-holding motor. — *A. K.*

LIGHT-PLANE FLYING

Its Future Depends on Small Engines

WHAT is a light airplane engine? It is an engine of under 100 horsepower, generally of the four cylinder horizontally opposed type, though sometimes having six cylinders. There are some engines under 100 horsepower which are of the in-line or radial variety, but the opposed-cylinder types take in 90 percent of the field. Three companies build these engines — Aircooled Motors Corporation, Aviation Manufacturing Corporation, and Continental Motors. Hence the name "Little Three Engines," which has been coined by Ralph S. White, the powerplane authority of the Civil Aeronautics Administration.

In a paper presented before the Society of Automotive Engineers—"Some Present-Day Problems in Light Airplane Engines" — Mr. White has made an exhaustive study of these engines, on whose functioning the future of popular flying depends in so large a degree. What is needed in the light-plane engine field? Practically the same characteristics as for the more powerful Wasps, Cyclones, and Rangers — more power for a given weight, dependability, low cost, efficiency, and so forth.

To date the light engine designers have not been quite as ambitious as the constructors of the more powerful motors. But now Mr. White predicts that even in the low-power field there will be a demand for reduction in noise; propeller gear-box reduction; metal propellers; controllable pitch wood and metal propellers; vibration damping equipment; oil filters; air cleaners; and automatic heat and mixture control for carburetors.—*A. K.*

FEWER WELDS

TEN years ago the welded steel fuselage reigned supreme. Now its position has been challenged by the monocoque or semi-monocoque fuselage of aluminum alloy, but, in the low-cost field, welded tubing still holds its own fully. Certain production requirements may again bring the welded steel tube into favor. A recent development of the Summerill Tubing Company may help; this development is the production of seamless tubing tapered in diameter and strength, and so more readily adapted to the tasks of airplane construction where the same length of tubing may meet widely varying load requirements along its length.

The tube begins as a pierced billet which is hot rolled into a tube. Then one end of the tube is heated to 1400 degrees, Fahrenheit, and is formed into one long cone closed at the end. The tube is annealed, pickled, and lubricated and is then elongated by a special process on the draw bench. With repeated drawing operations, the tapered tube is available for use. Space will not permit us to give more detailed description of the process but the application of the tapered tubing is clearly shown in one of our photographs. In the landing gear, the opportunities for using the new process are even more appealing than in the fuselage. — *A. K.*

Tapered tubing means fewer welds in aircraft construction

CAMERA ANGLES

Conducted by JACOB DESCHIN, A.R.P.S.

Make Your Movie Titles Live

TITLES suitably distributed throughout the run of the film are an essential part of the amateur movie story, giving it a completion that the title-less story does not have, particularly if it happens to be a fairly long run. A number of titling outfits that make the task an easy one are available on the market and the splicing of the title strips into the run of the film creates no more trouble than you normally have when editing and splicing the film story itself. Titling dresses up and otherwise embellishes the film so that it becomes more interesting and absorbing. Monotony is minimized or avoided altogether by good titles which break up the picture or clarify or emphasize the meaning and effect of a scene here and there.

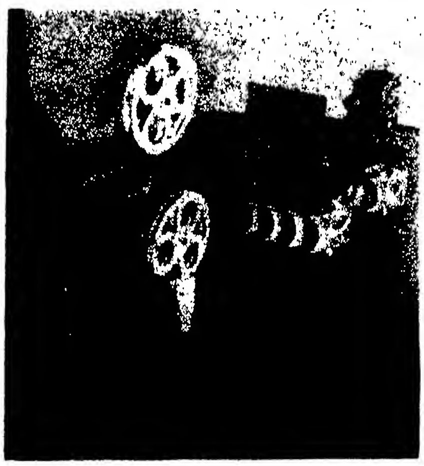


Figure 1

A fascinating phase of title-making is that in which an actual movie scene is used as a background, with the lettered title in silhouette. Recent experiments conducted by E. B. Lang, A. R. P. S., New York City, show that this can be done provided certain essentials are taken into account. Mr. Lang employed a Univex projector and titler plus the new Univex Cinemaster Double-8 movie camera. His set-up is illustrated in Figure 1, which shows a sheet of ground glass in place of an easel. This was held in position with strips of adhesive. A shim was placed back of the lens mount in order to bring the lens slightly forward and thus properly focus the camera for the short glass-to-lens distance.

An appropriate scene is selected from his files and projected from the rear, as shown, onto the ground glass, the ground side facing the projector lens. The smooth glass side facing the camera lens is used for lettering, either by writing or by mounting available rubber titling letters. In order to show the letters up properly, the projected background scene should not be too dark. A scene characterized by medium tone values is the best for the purpose. The projector light should be strong enough to permit a bright image on the screen, since we are re-photographing the scene, and the same conditions occur again that we would have in normal movie photography. Mr. Lang employed a 500-watt bulb, and this was found to be satisfactory. The camera lens must be stopped down in order to get lettering and scene into sharp focus, particularly critical at the short working distance employed in title-making.

Figure 2

Moving pictures appear to show scenes in actual motion only by reason of the phenomenon of persistance of vision: we know that a movie film is really composed of a string of still pictures. The projector moves the film so quickly—normally at 16 frames per second—that we do not detect any interruption. This is because, when we look at a picture, the image of that picture remains with us for an instant after the picture is removed from our line of

Figure 3

vision, but that instant, in observing a movie, is long enough to merge one image with the succeeding one, so that we imagine the picture is actually in motion.

To all intents it is in motion, but definitely there is a gap between each still. When re-photographing the scene with a movie camera, therefore, it is necessary to make an allowance for this. This may be done simply by shooting at more than the normal 16 frames per second. In Mr. Lang's experiments he used approximately 20 f. p. s. and found this speed completely adequate. The use of a small stop plus a faster taking speed makes a considerable demand on the film used, but this will be taken care of by using the combination of a strong projector light, a medium-toned background image, and a high-speed film.

A simpler method, though of course not quite so effective, is the use of a background projected by a still projector of the type used when showing Kodachrome slides. Here the problem is greatly minimized since you are merely photographing a still picture. Better than ground glass for this purpose is flashed opal glass because this avoids the hot spot and more evenly distributes the image on the glass. Figure 2 shows the use of the Brown Precision Titler for this purpose. The still projector is the Eastman Model 2 and the camera is the Filmo Magazine.

Figure 4

Figure 3 hows the use of the Brown Titler in making back-lighted titles. To avoid having the light strike the lens, a card is placed as shown. The angle of the light is illustrated by the idle unit at the left. Figure 4 shows how this titler is used when making so-called flip-flop titles. A title is set up on each side of the sheet-cork easel, one of the titles being arranged upside down with relation to the other. While the camera is operating, the title frame is turned evenly by a knob, as shown, from the first title to the second, being brought to a vertical position by a stop. A turn-around title is made by attaching a pedestal bearing to the bottom center, the pivot bearings being removed. A title is set up on each side, both right side up, and the title frame is rotated from the first to the second title while the camera is in operation.

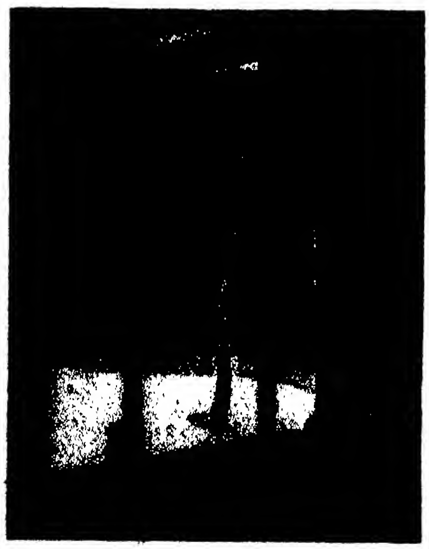
With the aid of devices such as these, title-making for movies becomes almost as exciting as shooting the the movie itself.

Rubber-Cementing Large Prints

When mounting large prints with rubber cement, it may be found difficult to get the print down evenly on the mount. As a result, small bumps appear in various places due to scattered air spaces between print and mount where the print failed to make contact with the mount, or some sections get down sooner than others due to failure in laying the print down in an even progression from start to finish. A practical method of avoiding this and making sure of good adhesion over the entire surface is to rubber-cement the back of the print and the surface of the mount as usual, and then tack down only one edge of the print. Before pasting down the rest of the print, insert a piece of wax paper between print and mount and press the print down so that part of the wax paper is adhering both to print and mount. Then slowly and carefully, pull the wax paper away. This will pull the print down to the mount, with some guidance, and insure close adhesion without air spaces. The method is particularly useful with single-weight papers.

Charm in Contrast

Offering a severe test for photographic materials as well as an interesting subject, the accompanying winter scene, taken from the warm vantage point of a museum interior, depends for whatever charm it may possess on the rather extreme brightness contrast between the shadows of



High-lights and shadow

OVER $1100 IN PRIZES
36 CHANCES TO WIN

Sixth Annual
SCIENTIFIC AMERICAN
AMATEUR PHOTOGRAPHY CONTEST

POPULARITY of the divisional method of judging photographs in the Scientific American Annual Contests, as determined by the enthusiastic response in past years, has been so great that the method is once more being used for the Sixth Annual Contest. In each of the divisions listed below there will be awarded seven major prizes and five honorable mention awards, a total of 36 prizes in all.

Please read the rules carefully and abide by them. Note particularly Rule 6, under which any contestant may enter a total of six prints, but no more than two in any single division.

Divisions In Which Prints May Be Entered

Division 1. Human interest, including camera studies of people, animals and so on. Portraits will be grouped in this division.

Division 2. Landscapes, including all scenic views, sea scapes, and so on.

Division 3. Action, including all types of photographs in which action is the predominating feature.

THE PRIZES

1st. Three $125 LONGINES, Coronation Model, Solid Gold, Men's Wrist Watches.

2nd. Three $90 LONGINES, Presentation Model, Solid Gold, Men's Wrist Watches.

3rd. Three International Marketing Corporation PHOTRIX "22" Enlargers, complete, less lens. (List price $54.)

4th. Three Burleigh Brooks FOTH-DERBY Cameras, with built-in coupled range finders. (List price $34.75.)

5th. Three WESTON No. 715 Exposure Meters. (List price $24.)

6th. Three ABBEY Vimo Flash Guns. (List price $13.75.)

7th. Three Raygram LEE Timers. (List price $12.50.)

Five Honorable Mention Awards, each to be a new or renewal subscription to Scientific American for one year.

Address all Entries to

Photograph Contest Editor, Scientific American
24 West 40th Street New York, N. Y.

Rules of the Contest

1. The groups will be judged independently on the basis of pictorial appeal and technical excellence. The decision of the judges will be final. In case of a tie for any prize, duplicate prizes will be awarded to the tying contestants.

2. Prints must not be smaller than 5 by 7 or larger than 11 by 14 inches. *All prints must be mounted, otherwise* they will be returned immediately.

3. Photographs must be packed properly to protect them during transportation.

4. Non-winning entries will be returned only if sufficient postage is included when the prints are submitted.

5. Each entry *must* have the following data written on the back of the mount. Name and address of contestant, type of camera, and film, enlarger, and paper used.

6. Contestants may submit no more than two prints in each group, but may enter any or all groups. In no case, however, will more than one award be given to any individual contestant.

7. Prints must be in black and white or monotone. Color photographs are not eligible.

8. Prize-winning photographs will become the property of Scientific American, to be used in any manner at the discretion of the publisher.

9. Scientific American reserves the right to purchase, at regular rates, any non-winning entry.

10. No entries will be considered from professional photographers.

11. All entries in this contest must be in the hands of the judges by December 1, 1941. Results will be announced in our issue dated February, 1942.

12. The contest is open to all residents of the Western Hemisphere who are not in the employ of Scientific American.

13. In fairness to all contestants, failure to comply with any of the above rules will result in automatic disqualification.

Names of the Committee of Judges Will Be Published in a Near Future Issue.

the interior and the strong highlights of the snow. The result was achieved with a negative of good contrast enlarged on a medium hard paper. More detail could have been saved in the shadows had a softer paper been used. In that case, however, the effect of strong outdoor light would have been dimished.

Scared?

WE wonder how great a percentage of the camera-toting public shies away from new methods in photography just because they are simply too scared to try them. Talking with workers, we have frequently had the feeling that they would go into toning or color photography or movies or lantern-slide making, if only they had the nerve. Licked before they even start, these defeatist fans can never know the possibilities of the newer fields unless and until they try. One good way to get rid of this negative attitude is to watch demonstrations of the new processes. Another, the most desirable way, is to buy the necessary materials and then go ahead and try your hand at the thing just to get the hang of it. It's surprising how quickly fear vanishes when results make their appearance—even poor results, which must be expected at the start.

Cropping Improves

THE two accompanying illustrations show, better than anything we might write, how greatly a picture may be improved by the simple process of eliminating from the original image all distracting details and concentrating on the main subject. None will doubt that Figure 2 is much better than Figure 1, yet this easy expedient of hoisting your enlarger higher than usual or making a smaller print to include only the wanted portion, is not practiced as generally among amateurs as it should be.

In our illustrations, you may notice that the angle of the baby's head and body is different in the finished result than in the first. This is another means of giving the print an added force. All you do is turn the easel until the picture looks right. The angle of the head in Figure 2 gives the baby's face a somewhat more lively and alert expression than in the original.

Figure 1: **The full negative . . .**

. . . and, *Figure 2,* as cropped

You can do your changing right on the easel, but it is simpler and more convenient to make a straight print from the negative and do your experimental cropping right on the print. Having determined the arrangement, you are all set to make the print.

Temporary Marks on Glass

MUCH as we would like to do so, it is not often convenient to provide a label for a bottle immediately after having mixed a particular solution, or when the solution is made up to be used right away, but there is always danger of mistaking it for another bottle made up at the same time, also for immediate use. Sticking on a label is a nuisance. There is now on the market a marking pencil called Phano, which can be used to write on glass and other glazed surfaces. It comes in several colors. One of these, of a contrasting color that can be seen against the background of the dark or light glass, as the case may be, serves very well for such temporary marking needs.

Scum Marks

FILMS, upon drying, are sometimes coated with scum marks, which interfere with printing. You can remove these when the film is dry by rubbing the surface with cotton soaked in methylated spirit or wood alcohol, or by immersing in the following: Boil a pint of water, then let it cool. Add one half ounce of hydrochloric acid, mix. Immerse the negatives, wet or dry, for one minute. Then hang up to dry.

Animating "Dot" Books

MAYBE you wouldn't know about it, unless you have recently been shopping for children's books, but there's a type of book known as the "dot" book because the illustrations

consist of a series of numbered dots. You draw a pencil line from No. 1 to No. 2, then to No. 3, and so on, thus gradually giving form to the picture.

Henry J. Brock, St. Marys, Pennsylvania, writing to Bell & Howell's *Filmo Topics,* makes the following suggestion:

"Could there be a more perfect set-up for using the single frame release? We had a lot of fun animating one of these books, and the youngsters, especially, enjoyed both the filming and the resulting picture.

"Set your camera and the dot picture firmly in place so that neither will be moved at all during the animation. Expose several frames of the picture as it first appears, and stop the camera. Draw a heavy black line from dot No. 1 to dot No. 2, and then expose a single frame. Extend the line to dot No. 3, and expose another frame, and so on. On the screen, the line magically extends itself to complete the picture."

To which the editor of *Filmo Topics* adds: "We are going to try Mr. Brock's suggestion soon. Perhaps we will also try another idea that just occurred to us. We'll use Kodachrome, and after the animation is complete, we'll start coloring the picture with water color —one brush stroke, one frame exposed, another brush stroke, another frame exposed, and so on."

Kodachrome Processing

KODACHROME film in the 35mm and Bantam sizes can now be processed at laboratories in Rochester, Chicago, and Hollywood, and should be sent to the nearest station. The addresses are: Eastman Kodak Company, 1017 N. Las Palmas Ave., Hollywood, California; Eastman Kodak Company, 1712 Prairie Avenue, Chicago, Illinois; Eastman Kodak Company, Rochester, New York.

Sound Films on Silent Projectors

ENTERTAINMENT and educational films in sound versions may now be projected on the new 16mm Filmo silent projectors, according to an announcement by Bell & Howell. The sound, of course, will not be reproduced, but there is now open to owners of silent projectors interesting and instructive films available only in sound versions.

Gunning for Ghosts

OUR Abbey synchronizer got a new experience recently when we used it in an attempt to get a picture record of one of the Scientific American sponsored spiritistic seances. We did not get any ghosts on the film but we did make some interesting records of human reactions at a typical seance.

Because the seance was to be conducted in total darkness and we were supposed to make the shots dur-

ing the session, we rehearsed three different positions before things got going. Each position was a distance of 15 feet from the table at which the medium was to be seated, two of the positions facing the medium, one facing the audience. Using Superflash Press 40 bulbs, we preset the exposure at 1/200 of a second, stop f/8. Mr. Dunninger, who directed the shooting of the pictures from his position next to the medium, gave instructions as to which position to take for different shots. This called for maneuvering about in the dark and occasionally kicking somebody's heels, but we got around okay except when we were asked to take a fourth position, unexpected before the seance, in still another part of the room. There was no opportunity for changing the focus, of course, so we did the best we could, getting a badly overexposed and out-of-focus "foreground" of two heads, though the point of interest farther away (about 15 ft.) was sharply recorded.

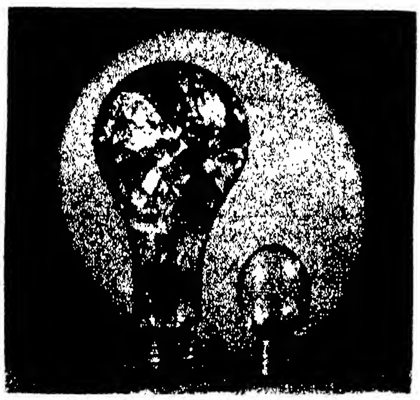
As "official photographer" of the seances, we shall have an opportunity later on to pass on some more of our experiences.

• • •

WHAT'S NEW

In Photographic Equipment

G-E AND WESTINGHOUSE MAZDA SPEED MIDGET PHOTOFLASH LAMP SM (13 cents each): Containing no wire or foil, similar in shape and size to "mighty midget" No. 5, permits action photography with inexpensive camera equipment. Also useful professionally

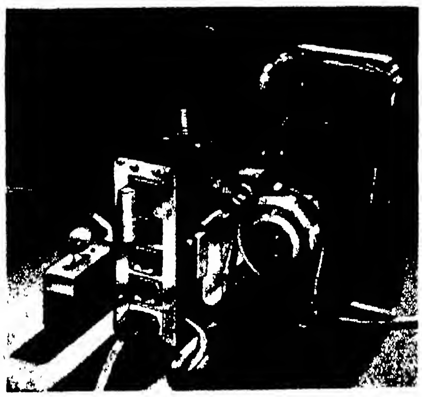


1931 . . . and . . . 1941

in close-up, color, clinical, and general shots. Comes to peak in 1/200 of a second, living its entire life in 1/100 of a second, therefore reaching peak four times faster than flash from No. 5 or other synchro-press lamps. Produces one fourth as much light as G. E. No. 5 but light volume ample when used with fast films. Human and animal subjects photographed by new speed midget said to be less aware of its mild flash of short duration than they are of flashes produced by other flash lamps. Revolutionary in design in that it employs

no aluminum leaf, free wire, or shredded foil within its bulb. Instead, contains small amount of chemical paste applied to ends of lead-in wires, in an atmosphere of oxygen; this produces flash. Makes possible easy synchronization with nearly all types of manual-set shutters, even box cameras. Lamp does not have to be given head start before shutter is tripped as lamp and shutter start simultaneously, thus eliminating many variables. Technical data: voltage—dry cells only (two or more); bulb—B-11; bulb diameter—1⅜"; maximum over-all length—2⅝"; base—bayonet (single contact); total light output (lumen-seconds)—2500-3000; peak lumens—500,000; time, closing of circuit to peak lumens—5 milli-seconds; approximate mean color temperature—3350 degrees Kelvin.

Cameratrol Photoflood Synchronizer ($9.95, complete with Remote Control Switch, 18-foot cables, two eight-foot lamp cords with male plugs, lamp sockets for Photofloods); Camera and lights operated by remote control switch after attaching Cameratrol to camera, fastening cable release, and plugging flood lamps into



two receptacles provided on Cameratrol. Hi-lo switch provides low intensity for focusing, full brightness, by throwing switch, for duration of exposure only. Small, compact, easy to use. May be attached to tripod or held in hand. Self-photography simplified. Any number of lamps may be used. Will fit almost every camera. Special tip for Leica available.

Panatech, Sr. Tripod ($5.50): All-wood construction, designed to take even heavy cameras without buckling, swaying, or tipping. When open, 60 inches high; closed, 34 inches. Wood hand-rubbed to smooth finish. Sure-grip locking device. Single extension legs equipped with special rubber pads to prevent slipping. Weighs 4 pounds, 6 ounces.

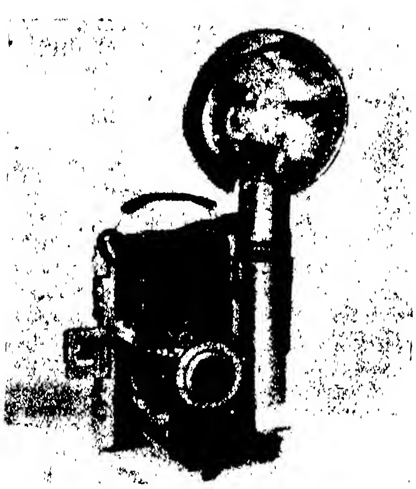
Improved Indiatone Paper: Projection and contact paper now richer in tone and easier to handle. Has good stability, latitude characteristics; marked by improved gradation

that exhibit softer highlight detail without sacrifice of shadow brilliance. Supplied in one grade on seven surfaces, double weight stock. Suitable for after-treatment with gold or sepia toners.

PRINCETON DYE-CAST FILTERS: Cast directly upon glass. Offered as successor to solid glass type filters. Have sturdy metal armor of finest grade brass. Available in complete selection of colors and sizes.

CRAIG FILM DRYER ($19.95): Dries negatives by forced warm air. Balanced temperature and airflow insures rapid, dust-free drying, desirable for high negative quality. Large drying surface accommodates approximately three rolls No. 120 film, or 16½ feet 35mm film; other sizes in proportionate amounts. Simple clip arrangement permits separate attachment of as many individual lengths of film as desired.

VIMO FLASHGUN (ABBEY) ($13.75): Professional type flash synchronizer for use with amateur type camera equipment. Vimo features: 100 percent electical tripper; high-speed action (no cocking or resetting between flashes); extra long battery life (350 or more flashes from size D cells); all shutter speeds synchronized up to and including 1/500



of a second; weighs less than 14 ounces; designed and built to last for years; pre-synchronized by electrical instruments at factory; professional type quick change socket; adjustable polished and plated reflector; compact, convenient attaching unit (no L-arms); minimum of projecting parts, therefore compact and easily pocketed.

R.H.S. 4x5 VIEW CAMERA ($32.50): Made of kiln-dried hardwood; weighs 4½ pounds. Joints dovetailed for rigid, permanent construction; dark mahogany with hard lacquer finish. Polished chromium metal parts, heavily plated; clamp screws provided with brass flanged nuts. Full 20-inch bellows extension. Cut brass focusing track mounted on full length of rigid camera bed. Back adjustable to swing and tilt forward or backward. Lens board has all adjustments: rising, falling, tilting. Lens board frame swings to left and right. Adaptable for commercial or portrait photography. Interchangeable reducing backs available ($4.50 each) 2¼ by 3¼ and 3¼ by 4¼ sizes.

TECHNICAL ASSOCIATES' DRY MOUNTING PRESS ($27.50): Mounts prints up to 11 by 14 inches on standard 16 by 20-inch mounts in any position on mount in one operation; larger prints in two operations. Heavy duty heating element, scientifically designed, assures even distribution of heat to all parts of pressure plate. Automatic time switch controls amount of heat applied to pressure plate. Press comes complete with tacking iron and detailed instructions.

HIPCO SYNCRO-MATIC SPEED-GUN ($3.95): Flash unit has new parabolic reflector (full sliding adjustment takes care of every size lamp); micrometer type adjusting screw; adjustment locking nut; plug-in type socket; scientifically designed adapter to use No. 25 or No. 5 midget bulbs; designed for speeds of 1/25 and 1/50 (higher speeds also obtainable); adjustable mounting bracket fits practically all cameras; fits any standard cable release; equipped with long life type C unit cells. Flash tester, consisting of finger plug, eight inches of wire, adapter for test bulb and test bulb—50 cents.

AGFA INFRA-RED FILM IN NEW SIZES: Used with red filter in bright sunlight, produces unusual tone effects varying from dark for blue skies to various tones of light gray to clean white for green foliage, light-colored buildings, white clouds, and so on. Average exposure with filter in sunlight 1/25 of a second at f/5.6 to f/6.3. Fine grain, moderately brilliant gradation, effective anti-halo protection. Now available in following sizes: A8 (same as 127)—$.40; PB20 (same as 620)—$.45; B2 (same as 120)—$.45.

DEJUR VERSATILE JR. ENLARGER ($55): Patterned after Versatile Enlarger. May also be used for wall projection, photo-micrography, copying and title-making, color reproduction. Has two 5-inch condensers. Negative range from 8mm to 3¼ by 3½ inches. Dual controls permit use of either right or left hand. Has DeJur exclusive "Aero-Teck" cooling system; heat-absorbing filter. Focusing by plastic knobs. Metal parts of finest quality steel, except for die-cast lamphouse. Laminated wood base-board specially treated against warpage. Micrometer - calibrated scales for designating angle of projection. Interchangeable lens-board; glassless, dustless negative carriers.

YOUR FIREARMS and FISHING TACKLE

Conducted by A. D. RATHBONE, IV

INTEREST IN FIREARMS *is traditional with American men; fishing tackle is a requisite of one of the world's oldest occupations. Scientific development of guns and tackle, in the use of which millions yearly find sport and recreation, fathers this monthly department which welcomes correspondence from readers.*

Regarding Nylon Leaders

DID you know that Spanish gut, one of the most widely used materials in the manufacture of leaders for fishing is taken from silkworms grown in Spain . . . that after these silkworms have reached their growth, they are killed by placing them in vinegar, then washed and torn apart to expose the sacs that secrete the silk? Did you know that the sacs are then pulled or stretched to form the gut, and that one result of this haphazard process is lack of uniformity in quality and gage of leaders?

Although this may sound like rank heresy to fishermen who have for years sworn allegiance to Spanish gut, it is a fact that few strands are even approximately round, and the thickness from end to end may vary by several thousandths of an inch. To try to secure uniform gage and to eliminate weak spots, it has been the practice to "draw" the natural strands through dies. This not only has increased the expense, but also has resulted in confusion on the part of manufacturer and buyer as to actual scales of sizes and gages.

Flexibility of Nylon eliminates snarls, improves night fishing

When the du Pont Company introduced Nylon to the angling fraternity, it offered a means whereby this uncertainty may be eliminated. That there are many other features favoring the use of the modern Nylon leader is attested to by the fact that 16 of our leading manufacturers are now selling Nylon leaders under various and sundry trade names.

If you would like to know more about the properties of Nylon, which is not to be confused with the so-called synthetic gut, drop us a line and we'll send you a 30-page booklet entitled "What You Ought to Know About Nylon Leader Material." It is published by the Plastics Department of E. I. du Pont de Nemours & Company, and will tell you how Nylon compares in strength with the best silkworm gut, about its durability, visibility, diameters, water absorption, flexibility, and much more of interest. A number of excellent knots are described and pictured, and the book is free.

The British Can Use 'Em!

THE American Committee for the Defense of British Homes, C. Suydam Cutting, Chairman, has offices at 10 Warren St., New York City. It is a committee of American citizens seeking gifts of arms, ammunition, binoculars, steel helmets, and stop-watches from American civilians to be sent to the Civilian Committee for the Defense of British Homes.

As of April 10th, the Committee had received 3562 guns, 4340 revolvers, 1975 binoculars, 359,603 rounds of ammunition, 9815 steel helmets, and 292 stop-watches. There is need for all types of pistols, revolvers, rifles, and shotguns using ammunition now procurable. Rifle ammunition (not soft nose) and ball or buckshot shells for shotguns are most acceptable.

There are now local committees in 288 communities throughout the United States, all co-operating with the main office in New York City, but if there is not a committee in your locality, and if you desire to help this worthy enterprise, send us a postal card for complete information, or write to the Committee's New York office.

Don't Do It!

FROM time to time we've warned against use of modern shotgun loads in guns with Damascus or other twist barrels. Although this warning has been concurrently issued for years by firearms editors and manufacturers of sporting arms, some gunners still think twist barrels will handle modern loads safely so long as the extra heavy "long range" loads are avoided. This is *not* true.

The Technical Committee of the Sporting Arms and Ammunition Manufacturers' Institute has studied this matter in scientific detail, and because of a persistent tendency on the part of owners of twist-barrel guns to ignore past warnings, the Committee says: "*Never* use smokeless powder loads—even *light* smokeless powder loads—in guns having Damascus or other twist barrels! Many of these barrels are the handiwork of highly skilled craftsmen. But regardless of the quality of workmanship employed, the method of combining low-carbon steel with iron, and the weakening heating process to which they have been subjected during manufacture, render them unsafe for the high pressures developed by modern loads, for which they emphatically were not designed.

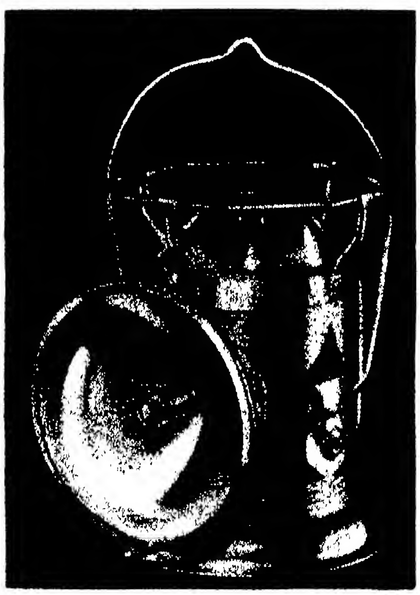
"American manufacturers have not made twist-barrel shotguns since the advent of modern progressive-burning, or 'smokeless' powder. If you own a Damascus or other twist-barrel gun, don't take chances. Retire it now, while both the gun and your fingers are still intact."

• • •

POT-SHOTS

At Things New

DELTA ELECTRIC COMPANY offers new 52-page booklet, "High Lights of Fishin'," by Mark W. Burlingame, noted angler, writer. This is companion volume to "Night Fishing," announced in these columns in January, 1941 issue. Delta Company's newest publication is packed with sound and tested ideas, fishing kinks, and methods for bass, bullheads, trout, crappies, muskies. Profusely illustrated with line drawings, encased in envelope conveniently ruled to six and one-half inches for use in measuring fish, and they're free. Want one?



Delta's "Powerlite" Lantern

J. STEVENS ARMS COMPANY, through engineering and research efforts of National Gas Furnace Company, is using new brazing process to unite shotgun barrels. Revolutionary from the standpoint of science as well as application of mass production principles to an old bottle-neck of the sporting arms industry, the new method assures gunners of more solidly brazed barrels, less possibility of their splitting apart from each other, or from the rib, due to sharp temperature changes or other factors. For full details, see page 332.

PETERS CARTRIDGE DIVISION OF REMINGTON ARMS COMPANY, INC., announces a new member in their family of "Inner Belted" Expanding Soft Point cartridges. This one is the .300 caliber Savage with a 150-grain bullet,

Peters .300 caliber cartridge

and 'tis said it will prove ideal for small and medium game of the fleet-footed type. It is particularly recommended for the Model 81 Remington, or other game rifles chambered for this caliber, and has the following ballistics:

Velocity, in foot-seconds—

Muzzle	100 yds.	200 yds.	300 yds.
2660	2430	2210	2000

Energy, in foot pounds—

Muzzle	100 yds.	200 yds.	300 yds.
2360	1970	1625	1325

Trajectory, in inches—

100 yards	200 yards	300 yards
0.7	3.0	7.5

KRAFT & COMPANY, makers of fishing specialties, offers stainless steel wire leaders in 6- and 8-inch lengths, which, because they employ the principle of snubbing, rather than use of a knot to fasten line to leader, materially add to line strength. As all good anglers know, the knot in terminal tackle is important, has instigated many fire-side debates, been the cause of many a good fish lost. It is the weakest point in any fishing line, for the knot tightens as line tension increases, and when

tension becomes strong enough, or has been repeated often enough, the knot may "pinch" the line apart.

By winding the line around the leader four or five times, as shown, strain from line tension is almost entirely taken up by the leader, with little strain applied to the simple knots, shown tied between and after two metal beads, which are integral parts of the leader.

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

WRITING on January 12, from Susak, Jugoslavia, Mirko Baretic, sent the photograph shown in Figure 1, and said, "Your good book, 'Amateur Telescope Making,' has reached this part of the world, and by following its instructions I made this very reliable instrument which has given me much satisfaction and many happy hours. It has a 7" mirror of 58" focal length. As we have no access here to discarded automobile parts, I made the mounting of heavy boards and it proved very satisfactory. The prism was taken from a discarded binocular. Entire cost did not exceed $10."

Baretic's letter reached these offices March 5 and not long afterward Jugoslavia was in the war. The Italian army was able to occupy his town of Susak, which lies just east of Fiume; there was no opposition, according to the daily press. One wonders where the telescope is now.

A telescope of this kind has no tube—simply a "spinal column" for support. Readers not familiar with telescoptics often ask whether this is all right. A tubular support for the optical elements of a reflector is mechanically convenient, also conventional, but is not necessary from an optical point of view.

PHOTOGRAPH of a grinding machine and amateur telescope maker, reproduced in Figure 2, reached us just before the first act of World War II, from Robert Wehn, Berlinerstrasse 37, Wermelskirchen, which our atlas shows to be close to Köln, or Cologne, Germany. We hinted to Herr Wehn that perhaps a Prussian telescope-maker's work would receive a better hand at some more fortunate time in world history and filed away the material. Now that things are worse, rather than better, we dig it out and publish it. Why? Just contrariness—we were born under the sign of the goat and goats are contrary; we had one.

Figure 1: **The Bareticscope**

Wehn says the machine was made by himself, according to the model of R. W. Porter. The power is a 1/5 horsepower motor and the spindle, crank-shaft, and main arm turn on ball bearings.

As Köln has been bombed many times, one also wonders where this apparatus is now!

IN his letter, Wehn recommends what he calls a "goatsfoot" for scooping out the channels in pitch laps. A goatsfoot is just a little rectangular piece of sheet metal, bent V-shaped and inserted in a wooden handle. The unchanneled lap is tipped up at an angle of about 45°, the goatsfoot is heated and started at the lower edge, cleanly cutting out and half melting out a strip of pitch as it is moved upward. This idea, in different variations, has previously been used by a number of American amateurs.

J. F. Bauer, Altoona, Pa., does it with a hot cold-chisel (if you'll pardon the term), ground to an edge having the shape of the desired channel section, held vertically and drawn along the lap as a plow. This, however, doesn't get rid of the two ridges pushed up on either side of the plow.

Wm. W. Peters, of the Department of Physics at Santa Barbara College, Santa Barbara, Calif., marks off the lines for the channels and then softens the pitch adjacent to them with a piece of electrically warmed resistence wire stretched across a hacksaw frame. He then uses the scraper shown in Figure 3 to remove the pitch.

Our vote still goes to Bill Mason's Hot Plow principle, described here in December, 1935, and now repeated. Figure 4 tells the story, except that Mason said: "Do not try to make the groove full depth at the first stroke, also pull the plow through the pitch rather than push it, and do it slowly."

Figure 5 is a modification of this design, devised by Prof. Henry L. Yeagley, of the Pennsylvnia State University. Here the plow is attached diagonally to the end of the soldering iron and the lap is held vertically so that the plowed out pitch automatically falls aside.

Russell Porter tells us that the workers in the optical shop at the California Institute of Technology do it thus: The lap is poured and fixed in a horizontal position. A large knife is slowly passed through a flame, which heats it, and is then drawn through the lap. This melts and draws off some of the pitch. The pitch is scraped off by a V-shaped "scraper-offer" and, after several repetitions of this, the channel is finished.

The "Pittsport Door Mat," so-called,

Figure 2: **RAF target**

or rubber grid, for making laps semi-automatically, as devised in 1935 by amateur telescope makers Everest, Munn, Morse, and Carlson, is still to be had, we learn, from the original makers, The H. O. Canfield Co., rubber works, Bridgeport, Conn., postpaid anywhere for a greenback. Its use is explained in "A.T.M.A."

STELLAFANE convention, Saturday, August 2.

EVEREST, in "A.T.M.A.," suggests that abrasives used in grinding be washed, or settled, even when taken directly from the can as purchased. Your scribe recently tried this and never a scratch was scratched. Dump the grains into a glass, stir vigorously till all are in suspension, let them

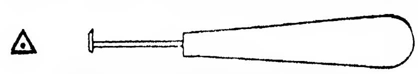


Figure 3: **Peters' channeler**

settle, pour off the water, and spoon off the upper two thirds for use. If reckless, chuck the rest or, if Scottish, repeat the process with it and in turn with its remainder, and so on and on, till you faint.

Kerosene for later grinding stages, instead of water, behaves normally, and no muss need be anticipated if the oil is dispensed from some kind of container having a small, controllable flow, also if something is provided to catch all the drippings from the tool. For grinding three stages, also slushing off between wets, a single pint of kerosene is enough. Fine abrasives that remain wet, or even damp, with

water, will spread badly on the tool with kerosene, hence they should either be dried up bone dry first, or washed in kerosene in the first place and put on wet with it.

COMPARISET: "T.N.'s may have difficulty in judging whether the pits from any grade of abrasive have been completely removed by the next finer grade, even when using a magnifier," Cyril G. Wates, 7718 Jasper Ave.,

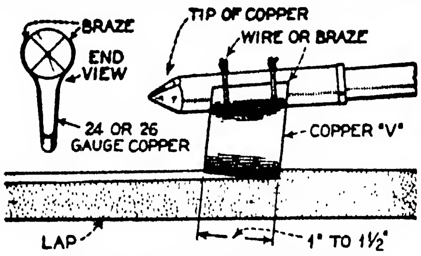


Figure 4: **Bill Mason's plow**

Edmonton, Alta., Canada, observes and continues:

"I have found the following stunt helpful: Suppose we are using eight grades of abrasive. Cut nine pieces of plate glass (old windshield), each about 2" square. Take one piece as the tool, and mark the back of it. With this grind *both* sides of the other eight pieces, each with a different grade of abrasive. Wash the tool carefully between grades, of course. Mark each sample on one side only with the grade used. Now go back to the glass on which the coarsest grade was used, and grind the unmarked side for a minute or two with the next finest grade. The object is not to remove the pits but to show a surface partly ground with grade No. 2 and containing pits from grade No. 1. Do the same thing with every other piece, and you will have a set of samples by means of which you can judge the appearance of a mirror at every stage of coarse and fine grinding."

Now and then a new—or old—reader of "A.T.M." writes this department to say that Ellison was not justified in his claim to the discovery of the auto-collimation test for objective lenses, described on page 121 of "A.T.M." Recently, while reading page 166 of *English Mechanics* for April 4, 1924, we there stumbled

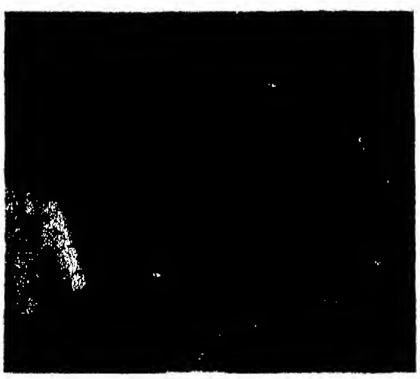


Figure 5: **The Yeagley plow**

across a letter by Ellison in which he stated clearly that he only discovered it "independently." Four years later, when he prepared the material on the objective lens, for insertion in the second edition of "A.T.M.", he did not make any change in the claim for original discovery. The reader may make of this what he can.

BEFORE he made the 20" reflector described with numerous photographs in the October, 1939, number, William Buchele, 2832 Sagamore Road, Toledo, Ohio, made the Gregorian shown in Figure 6. "The drive," he points out, "is essentially the same as the Sellers alarm clock drive described in 'A.T.M.A.', page 275, except that I used a sector of a drum and a thin cable instead of a triangle plate and lever, since a lever action cannot give a uniform pull. Figure 7 shows the arrangement, also the device for

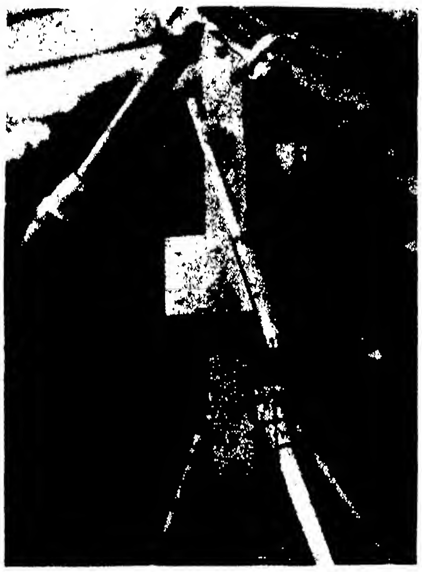


Figure 6: **Buchele's drive**

plumbing up the telescope, which is a portable and is mounted on a tripod.

"The axes of the telescope mounting are bicycle hubs and they moved so easily that I had to add a counterweight to keep the cable tight. Both axes contain small clutches and worm gear slow motions.

"The f.l. of the primary is 27½" and the e.f.l. of the two mirrors is 165—much too great for a 6"."

Recently, Buchele added to his collection the 12" Cassegrainian shown in Figure 8. He writes:

"The focal length of the primary is 29", which means a deep curve, and I had to bear down on the mirror 14 hours merely to parabolize it. [On two mirrors of even shorter focal ratio, Lower, also Ferson, parabolized mainly in grinding.—*Ed.*]. The secondary was even more difficult. The effective focal length of the telescope is 100".

"The finder is a 3½" of 22" focal length, with objective taken from a projector. Not quite achromatic but not bad. However, I do not need the

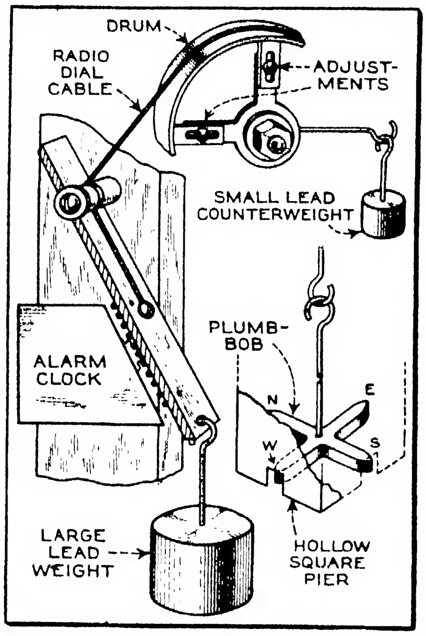


Figure 7: **Buchele, detail**

finder, since the field of the Cassegrainian itself is wide.

"I have also built the clock described by Souther in 'A.T.M.A.', and it works fine. The hour index is stationary and the face of the clock has numerals, 1 to 24, with a complete star map of principal stars down to —30°. This rotates in a counterclockwise direction. I have it mounted on the north wall of my observatory and the illusion is very realistic, with the star map rotating just as do the stars above, at sidereal rate. The minute hand rotates in a clockwise direction, with the minutes lettered on the glass, which, of course, is stationary."

Asked how the job of building the clock went, Buchele states that "it was interesting. I did not have any real trouble. I believe the cost was lower than Souther estimates in 'A.T.M.A.'"

Figure 8: **A 12" Cassegrainian**

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with a list of available titles, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for.

BROADWAY STOMACH

By Joseph F. Montague, M. D.

TROUBLES caused by emotional stress, high-pressure nervous tension, the worry-worry and the everlasting hurry-hurry and senseless super-drive of American life, also by anxiety, reacting on the food canal, cause what this author calls "Broadway stomach," but which is almost as prevalent all over the nation as in flighty New York. Dr. Montague is a stomach and intestinal specialist who here explains in lucid layman language the cause and mechanism of nervous tension and its reaction on our insides, and he deals specifically and at some length, not merely vaguely and generally, with ulcer, acid stomach, dyspepsia, gallstones, gas in the stomach, adhesions, fallen stomach, colitis, diet, constipation, cathartics, cancer, appendicitis, headache, dizzy spells, nervous breakdown, effects of liquor, coffee and tobacco. He tells the details a busy doctor might explain to a patient if he only had the time. (356 pages, 5¼ by 8 inches, illustrated.)—$2.10, postpaid.—*A. G. I.*

GETTING ACQUAINTED WITH RADIO

By Alfred Morgan

SIMPLIFIED information on the fundamentals of radio theory and equipment is presented here, accompanied by helpful and pertinent illustrations. All of this leads up to several chapters on the construction of simple receivers and transmitters, learning to transmit, and obtaining a license. (285 pages, thoroughly illustrated, 5½ by 8½ inches.)—$2.60 postpaid.—*A. P. P.*

WHITTLING BOY

By Roger Burlingame

IRONICALLY, the invention of the cotton gin, for which he is universally credited with fame and fortune, brought Eli Whitney little but trouble and sorrow. His great contribution to American industrial progress was the first conception of the principles of mass production, initially applied, through his country's necessity for national defense preparations, to the manufacture of army rifles. The dramatic story of Whitney's struggle to become a lawyer rather than one of this country's inventive geniuses, his heartbreaks and setbacks due to the cotton gin, and his final victory after near-bankruptcy at 35 years of age are ably told by this author, who has steeped himself in the fascinating and little known facts of Whitney's life struggle. Written in free, fast-moving style, there isn't a dull moment in this story. (370 pages, 5½ by 8½ inches.) — $3.10 postpaid. — *A. D. R., IV.*

THE FLEET TODAY

By Kendall Banning

YOU, who wish the facts, or that lad you know who itches to join the navy, will learn from this very readable, human and often humorous, but most informative book, exactly what navy life is like for lower ranks, from the day of applying clear through the term of service in various specialties. It answers a thousand questions that might be asked. (346 pages, 5¼ by 8 inches, 32 illustrations.)—$2.60 postpaid.—*A. G. I.*

WE PRESENT TELEVISION

Edited by John Porterfield and Kay Reynolds

A NUMBER of authorities in the various branches of television—technical, program, financial—answer in this book practically all of the questions that the average intelligent reader might ask in endeavoring to grasp the television situation from the standpoint of its implications on present and future communication, education, and entertainment. (298 pages, a number of photographs and drawings, 6 by 9 inches.)—$3.10 postpaid.—*A. P. P.*

DYKE'S AUTOMOBILE AND GASOLINE ENGINE ENCYCLOPEDIA

By A. L. Dyke

ONCE again comes a new edition—the 19th—of this grand old standby of the technically-minded automobile owner, garage man, and technician. Numerous additions to the former edition bring the text thoroughly up to date. Besides a complete

treatment of the automobile gasoline engine, there are included sections on Diesel engines, fluid drives, outboard motors, aircraft engines, and other modern developments in the transportation field. (1483 pages, 4600 illustrations, 7 by 10 inches.)—Cloth, $6.50 postpaid.—*A. P. P.*

NEW HANDBOOK OF THE HEAVENS

By Bernard, Bennett, Rice

EASY chapters painlessly covering the constellations by seasons: southern hemisphere stars; planets; Moon, Sun; comets; meteors; asteroids; double and multiple stars; variables; clusters and nebulae; units of the universe; celestial photography; use of the telescope—as taught at the Hayden Planetarium in New York. A fine observing list of doubles and multiples, with coordinates, is given. Good introduction to astronomy for those who do not wish outright textbooks. A semi-textbook. (299 pages, 6 by 9 inches, 77 illustrations.)—$2.60 pospaid.—*A. G. I.*

VACUUM TUBE VOLTMETERS

By John F. Rider

THE combination of the vacuum tube and voltmeter has been developed into one of the most valuable aids to the engineer and research worker. Under the name of the Vacuum Tube Voltmeter it is now available for measuring practically all types of voltage and current, as well as resistance. This book contains a practical description of the numerous types of these voltmeters and should be of interest and value to those in the field whose work involves accurate electric measurements. (180 pages, 5½ by 8½ inches, many illustrations.)—$1.60 postpaid.—*A. P. P.*

TIME AND ITS RECKONING

By R. Barnard Way and Noel D. Green

ELEMENTARY, general treatise on time in astronomy; sun-dials; clock mechanisms; watches and chronometers (escapements and movements, rating); unusual clocks and watches; electric clock principles; public time; nature of time. Not a specialized book but a brief introduction. (137 pages, 5½ by 8½ inches, illustrated.)—$2.10 postpaid.—*A. G. I.*

THE ART OF TYING THE WET FLY

By James E. Leisenring, as told to V. S. Hidy

ALL too few in this nation of anglers are the fishermen who truly know the art of wet-fly fishing for trout. Still fewer are they who have set their knowledge in type that others may learn. Such, however, is the author of this book, an angler whose lifetime of experience has been clearly and simply condensed into 12 fascinating

chapters. For the angler who ties his own flies, this book bulges with facts; for the fisherman who buys his lures, it offers invaluable suggestions on a little-known phase of trout fishing—how to fish the wet fly. (102 pages, 5 by 7 inches, 17 full page plates, 11 line drawings.)—$2.10 postpaid.—*A. D. R.*

MORE YEARS FOR THE ASKING

By Peter J. Steincrohn, M.D.

HEADING off the ills that kill us untimely, by making use of the facilities afforded by science, is the major theme of the book, which gives sensible advice on heart trouble, blood diseases, cancer, stomach trouble, kidney disease, tuberculosis, diabetes, blood-pressure, pneumonia, and nerves. The style is personal and breezy. The book reflects more about the lives of doctors and their daily dealings with patients than doctors usually divulge. (218 pages, 5 by 7¼ inches, unillustrated.)—$2.10 postpaid.—*A. G. I.*

MODEL GASOLINE ENGINES

By Raymond F. Yates

THE amazing growth of the hobbies involving gasoline-powered model automobiles, motorboats, and airplanes is the underlying reason for the appearance of this book, complete as to detail. Described in the text are the operation of model gasoline motors, how to take care of them, how to "shoot trouble," some of the fundamentals of building models and how to install the motor in these models, and, finally, a chapter on radio control for gasoline-engined models. The book has been prepared with both the beginner and the advanced hobbyist in mind. (241 pages, 5½ by 8 inches, numerous drawings and photographs.)—$2.60 postpaid.—*A. P. P.*

TIME AND ITS MYSTERIES

By Hering, Swann, Dewey, Compton

SERIES II of the James Arthur Foundation lectures given at New York University. The lectures are: (1) The Time Concept and Time Sense among Cultured and Uncultured, by Daniel Webster Hering, physicist. (2) What is Time? by the physicist, W. F. G. Swann. (3) Time and Individuality, by the philosopher, John Dewey. (4) Time and the Growth of Physics, by the physicist, A. H. Compton. Emphasis throughout is on the philosophical. (137 pages, 5½ by 8½ inches, unillustrated.)—$2.10 postpaid.—*A. G. I.*

METEOROLOGY

By Donald S. Piston

REVISED edition of a standard elementary text for college courses, aviation students, and others, with added elementary material on air mass analysis. (233 pages, 5¾ by 8½ inches, 113 illustrations.)—$3.10 postpaid.—*A. G. I.*

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

HERE TODAY is a title of this year's illustrated tabulation of automobile accidents during the preceeding year. Special features, aside from factual material regarding accidents themselves, include editorials on such factors as the traffic problem, speed, pedestrian accidents, and the need for greater courtesy on the highways. *Travelers Insurance Company, Hartford, Connecticut.—Gratis.*

IRVINGTON VARNISHED FIBERGLAS is a folder which gives details of this material that is finding wide-spread use in electrical equipment. Small samples of the varnished fiberglas are attached to the folder. Request this on your business letterhead. *Irvington Varnish and Insulator Company, 24 Argyle Terrace, Irvington, New Jersey.—Gratis.*

FARMERS IN A CHANGING WORLD is the 1940 Yearbook of the United States Department of Agriculture, containing 1200 pages of readable chapters by two-score writers on the economic and social conditions in current American agriculture. *Superintendent of Documents, Washington, D. C.—$1.50.*

WABASH EXPOSURE BULLETIN, FORM 732p., is a four-page leaflet containing the latest data on flash, flood, and color photography. The leaflet lists all popular films with complete exposure tables for their use in flash and flood photography with between-the-lens shutters, as well as focal-plane shutters, from the miniature camera size to 4 by 5 cameras. A special page is devoted to color photography, with the latest exposure data tables available for both indoor and outdoor use with flash and flood. *Wabash Photolamp Corp., Brooklyn, New York.—Gratis.*

HOW PRECISION INSURES CATERPILLAR QUALITY is a 40-page completely illustrated booklet which deals with the high degree of accuracy employed in the manufacture of these well known tractors. The machines and gages which are necessary for production to within a few millionths of an inch of accuracy are discussed and illustrated in considerable detail. *Caterpillar Tractor Company, Peoria, Illinois.—Gratis.*

MY FISH FRIENDS is a 32-page booklet depicting 17 species of fresh water game fish in their natural colors. It contains basic facts and information concerning each species, a table showing natural habitats in the United States, and a study of fish conservation methods. — *60 cents.* TEACHERS' AND STUDENTS' MANUAL is a 100-page book to accompany the preceeding booklet and offers educational information on life cycles, feeding habits, and other icthyological data in simple, illustrated form for use with younger children. *—Myron E. Schoemaker, Laceyville, Pennsylvania.—$1.00.*

BLUEBERRY CULTURE is a circular in which are fully described the soil and cultural requirements for the successful propagation of this particular bush. *New York State Agricultural Experiment Station, Geneva, New York.—Gratis.*

TEXROPE DRIVES is a 16-page booklet presenting facts and data essential in estimating costs, types, and sizes of V-belt drive equipment by engineers and buyers in industry. Complete information is also included on various types of sheaves. *Allis Chalmers Mfg. Company, Milwaukee, Wisconsin.—Gratis.*

REPORT ON BENTONITE, by Ben F. Powell, Construction Engineer, United States Forest Service, demonstrates the use of this versatile mineral to impede seepage in small dams. *The Wyodak Chemical Company, 4600 East 71 Street, Cleveland, Ohio. —Gratis.*

PLASKON RESIN GLUE is a colorful, illustrated pamphlet that puts forth the features and advantages of this particular type of adhesive. Illustrated are many specific applications which in themselves will suggest even wider uses. *Plaskon Company, Inc., 2112 Sylvan Avenue, Toledo, Ohio.—Gratis.*

FIRE-PROOFED WOOD is a report of the Committee on Fire Proofing of the American Wood Preservers Association, with particular reference to the ignition of roofs by incendiary bombs. Progress in this direction, both here and abroad, is reported, some of the tests employed being aimed at a fire insurance rating for fire-proofed wood. *H. L. Dawson, 1427 Eye Street, N.W., Washington, D. C.—Gratis.*

BUTTERFLY VALVES is a 12-page bulletin illustrating and describing new models of standard and wafer type butterfly or blast gate valves for the control of air, gas, steam, and liquids. Data are presented on both manual and automatic controls. *R-S Products Corporation, Wayne Junction, Philadelphia, Pennsylvania—Gratis.*

LUMBER DISTRIBUTION AND CONSUMPTION FOR 1938 is the biennial report on this subject which has just been issued by the Forest Service of the United States Department of Agriculture. It gives the latest figures on exports and imports, amount of lumber cut in the United States, per capita utilization, and so on. *Miscellaneous Publication No. 413. Superintendent of Documents, Washington, D. C.—15 cents.*

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WELDING

Printed in the U. S. A. Press of the Wilson H. Lee Company, Orange, Connecticut

SCIENTIFIC AMERICAN

complete

Photograph by Robert Yarnall Richie

Welding Breaks Bottlenecks

18990

OUR SEARCH FOR THE SUPERNATURAL—IV

Did Sir Oliver Lodge Write the Message?

WELDING, a proved tool of industry, has an important job to do in the scheme of national defense. As told in the article starting on page 8 of this issue, welding brings to the machine tool industry not only a faster production method but also the possibility of using superior methods at less cost. Photograph by Robert Yarnall Richie, courtesy Wyatt Metal and Boiler Works.

SCIENTIFIC AMERICAN

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NINETY-SEVENTH YEAR • ORSON D. MUNN, Editor

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JULY · 1941

18992

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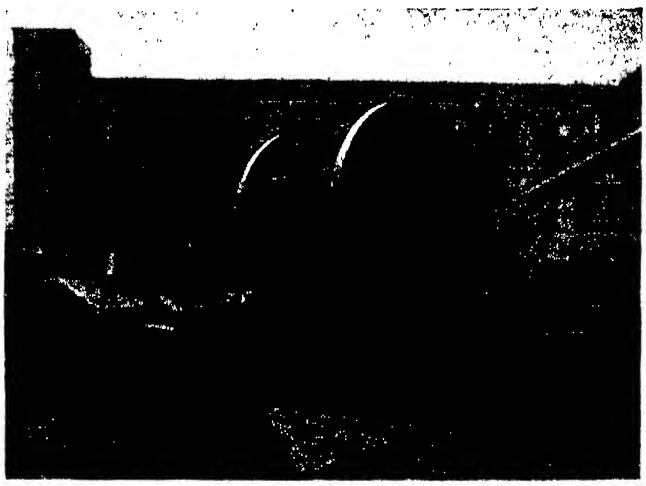
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of July, 1891)

WEALTHY ELECTRICIANS—"No scientific body in the country has so many millionaires as the American Institute of Electrical Engineers. At the top of the list is Alexander Graham Bell, whose profits on the telephone are represented by eight figures. Next comes Edison with a seven figure fortune. Brush, of electric light fame, and Elihu Thomson, whose financial future is perhaps brighter than any of the others now, are more than millionaires, and a score of others have independent fortunes. Most of these men were telegraph operators, and most of them began their experimenting and study without a dollar."

CABLES—"The extensive use of street cable railways has necessitated the manufacture of wire ropes of great continuous length, and the problem of transporting such ropes, without injury, from the manufactory to the place of use, is a serious one. . . This is successfully solved by Messrs. John A. Roebling & Co., of Trenton, N. J., whose cable railway ropes have become everywhere famous for



Shipment of street railway cables

excellence. . . A single Roebling cable sometimes is required to have a length of 6½ miles. Such a rope, 1¼ in. in diameter, will weigh 42 tons. It is reeled upon a single spool, over 10 ft. high, as shown in our engraving, which is from a photograph. A special car of superior strength receives the great package."

LOCOMOTIVE WATER—"The system of taking water into locomotive tender water tanks without stopping the train has been quite extensively introduced upon some of the leading railroads of this country. . . An iron trough is laid upon the sleepers. It is 6 inches deep, 18 inches wide, and about 1,200 feet long. . . The tanks, of 35,000 gallons capacity each, are fed by two Blake pumps. . . A dipper or movable chute is carried by the locomotive tender. It is arranged so as to be raised or lowered at will by a lever. . . To take in water the fireman lowers the dipper. As it meets the water in the tank, the latter is forced up in great volumes into the tender tank. From one trough two thousand two hundred gallons can be taken in on passing"

URANIUM STEEL—"Among the ores recently found in the Black Hills has been that rare and valuable mineral uranium. Although it has only appeared in one place, situated in the Bald Mountain district, it is found there in such large quantities as to warrant the prospect of early production of uranium salts, as well as the metal uranium, in the United States. . . Experiments and tests which have been made by the great steel and gun manufacturers in England and Germany have shown that the addition of a small percentage of uranium to steel increases its elasticity, and at the same time its hardness, to an extent that makes its use in the manufacture of guns, armor plates, etc., most desirable."

SHIP BITES WHALE—"While cruising with the Channel squadron, writes an officer of H.M.S. Immortalite, at nine o'clock on the morning of the 26th of May, in lat. 38 deg. 7 min. N, long. 9 deg. 19 min. W, steering S¼W (about midway between Sardinia and the African coast), and going at a speed of thirteen knots, we struck a whale, about forty-five or fifty feet long, with our ram. It was unable to clear itself, which necessitated our going full speed astern, when the whale sank."

TWELVE-INCH GUN—"The first 12-inch steel gun made in the United States has been completed at the Watervliet Arsenal, West Troy, N. Y., and shipped to the Sandy Hook proving ground for testing. This is the largest steel gun ever built in this country. . . The gun weighs 52 tons. It is 36.66 feet long and the length of the bore is 34 feet. Its charge is 440 pounds of powder, and its projectile weighs 1,000 pounds. . . The initial velocity of the projectile will be 1,940 feet per second, the muzzle energy 26,000 foot tons. At the muzzle this projectile will penetrate 32 inches of iron, and at a distance of two miles 20 inches."

SAIL AND STEAM—"The sailing vessel is rapidly passing into the limbo of forgetfulness, and the deep and fast steamer is gathering to itself the business of the Great Lakes carrying trade. The lumber traffic still adheres to the sailing vessels, but iron ore, coal, wheat, flour, and merchandise go to the steamers for low rates and quick transit."

HIGH-PRESSURE STEAM—"In the early days of steamships on the Atlantic the steam pressure carried was five pounds only above the atmosphere, and the engines made from 10 to 12 revolutions per minute; the vessels made 8 knots per hour on an average. Now we carry exactly 36 times the pressure, make 7 times the revolutions, but go only 2½ times faster."

COAST SURVEY—"After nineteen years the United States steamer Hassler has completed the survey of the California and Oregon coasts."

ELECTROCUTION—"The new law of the State of New York, for the execution of criminals by the electric current, instead of by hanging, was enforced for the second time on the 7th of July, upon the bodies of four murderers. The execution took place at the Sing Sing State prison. . . The experience has proved that this method is superior to any other yet devised."

Personalities in Science

JOSEPH SLEPIAN

IN 1915, Dr. Joseph Slepian, tired of teaching mathematics and anxious to work with motors and electrical things, put away his textbooks and took a job winding railway motors in the East Pittsburgh Works of the Westinghouse Electric & Manufacturing Company. Today he holds the position of associate director of the Research Laboratories of that organization. His inventions have played an important part in the last 20 years' development of electric power systems. He developed the modern lightning arrester which safeguards power lines and equipment. He and L. R. Ludwig, another Westinghouse engineer, invented the Ignitron, a device which changes alternating current electricity into direct current—essential in such processes as the manufacture of aluminum. His "De-ion" principle for putting out electric arcs fast helped make possible the distribution of electric power at the high voltages in use today.

Born in Boston in 1891, Dr. Slepian received his Ph.D. degree from Harvard University in 1913 and studied higher mathematics at Gottingen University in Germany and Sorbonne at Paris the following year. Later he taught at Cornell University. Despite the fact that his formal education included nothing about electrical engineering, Dr. Slepian has become one of the world's outstanding electrical engineers.

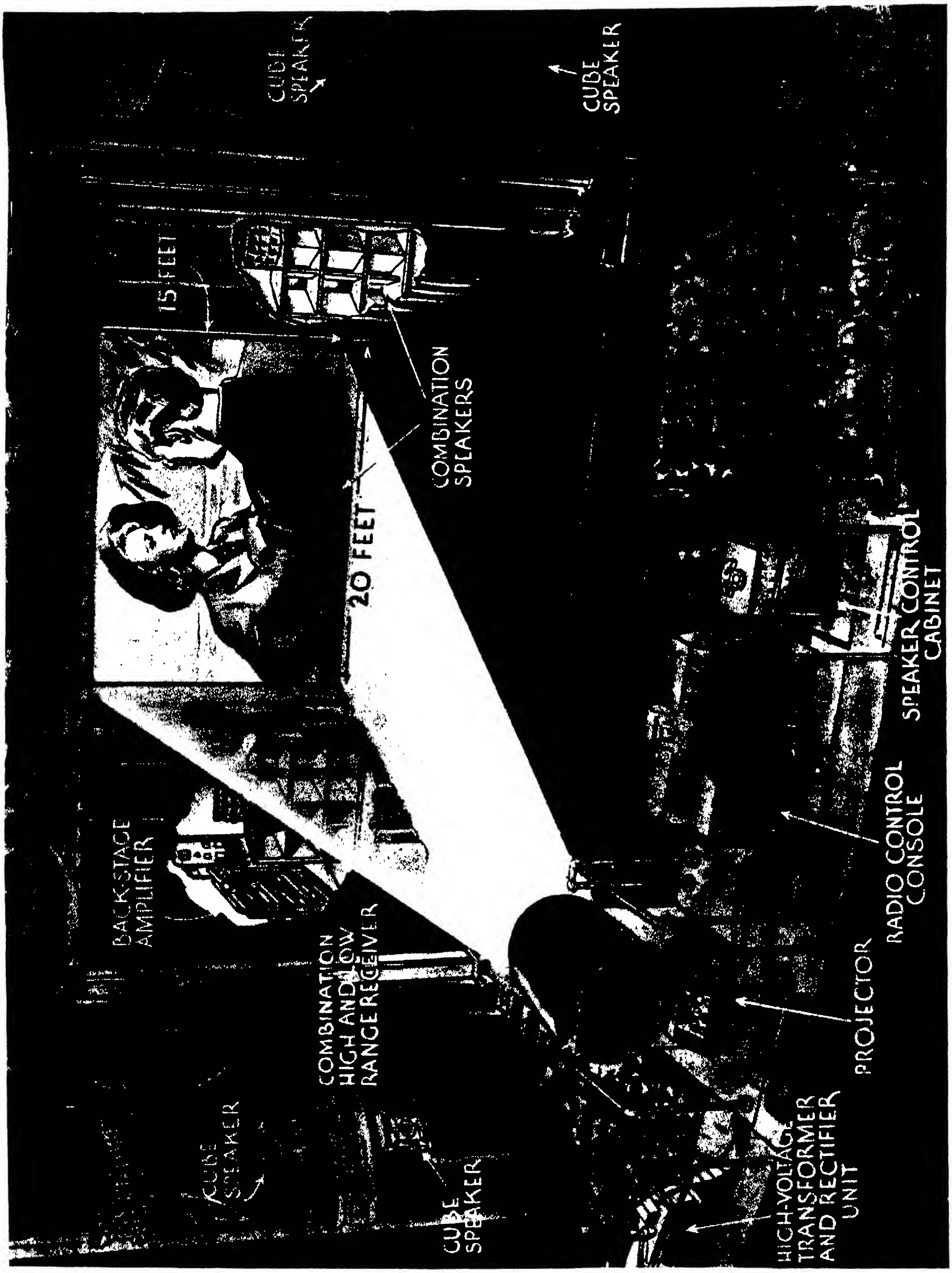
After joining Westinghouse, he began reading books on electrical engineering and soon was assigned to routine service problems and testing materials in the research division. Word got around that young Slepian had the answers to a lot of tricky technical problems, and experienced engineers began seeking his advice. When he told his foreman that this interfered with his regular work, the foreman said to let the routine work wait. Dr. Slepian did, and within six months he was asked if he would like to move up to the main research engineering office. His answer was "Fine"; but nothing more was said about it. When he thought he had waited long enough, Dr. Slepian found a vacant desk in the research office, picked up his books and papers and moved in. That he was permitted to keep his desk, Dr. Slepian explains, "just goes to show how a big company can still be flexible enough to allow a man to make his own niche."

It became clear to most electrical engineers in 1922 that the electrical systems in the country had just about reached the limit of ability to carry higher voltages because switches which could break high-power circuits of greater voltages were big, slow-acting, and expensive. Up to 1922 they had handled arcs as a fire, putting them out by cooling and chilling them. But it seemed to Dr. Slepian that a better understanding of the arc's nature from the standpoint of a physicist was needed. He recalled the theory that molecules of gas or air are broken up into ions when an electrical current passes through the gas.

In conventional alternating current systems, the current passes through zero 120 times a second or makes 60 cycles a second as it alternates forward and backward. At these zero points the current is not creating any new ions but is losing them. So Dr. Slepian reasoned that if he could make the ions disappear faster at the zero points, there would not be any ions to carry the current when it was ready to move again.

Discovering that there was a layer near the negative electrode which lost its ions quickly, Dr. Slepian created a series of these "de-ionizing" layers by breaking up the big arc into a lot of smaller arcs, each with a layer in which the ions disappeared quickly—and a new era of high-power transmission opened up.

Dr. Slepian is married and has two sons—Robert, 21, and David, 17. For relaxation, he depends upon good music. But his real hobby is keeping track of David's hobbies, which include photography, metal working, and microscopy, among others.



THEATER TELEVISION

LARGE-SCREEN television pictures, made possible by a projector developed by the RCA Laboratories (see page 27 for more details), have been successfully demonstrated under commercial conditions. Drawing above shows arrangement of equipment required.

97TH YEAR SCIENTIFIC AMERICAN JULY 1941

OUR SEARCH FOR THE SUPERNATURAL—IV

Did Sir Oliver Lodge Write the Message?

A. D. RATHBONE, IV
Secretary, Scientific American Committee for the Investigation of Psychic Phenomena

DURING the evening of May 12 the Scientific American Committee for the Investigation of Psychic Phenomena witnessed a manifestation of alleged "spirit-writing" by Reverend Edward Lester Thorne, President, United Spiritualists' Church. The demonstration took place in his church, which is located at 257 Columbus Avenue, New York City, and was presented before members of one of Dr. Thorne's "developing classes," representatives of the press, guests, and the following members of our Committee: Messrs. Dunninger, Bendix, Kane, Kraus, Odlum, Peck, and the Secretary of the Committee. The so-called "spirit-message" consisted of one word, purported to come from Sir Oliver Joseph Lodge, and, according to the Reverend Thorne, was written and signed by the spirit hand of the late British physicist. That single word held special meaning for Dunninger, who stated that it was a key word to one of the three secret messages confided to him in code by Sir Arthur Conan Doyle, Thomas Alva Edison, and Houdini before their respective deaths, in efforts to test the theory of spiritual return to this world.

Before an audience of some 40 persons, including the "developing class," the seance convened shortly after six o'clock with introductory remarks by Dunninger, who emphatically reiterated that neither the publishers of Scientific American nor the special investigating committee questions, debates, or in any way attacks any form of religion, religious belief, or cult in the search for realism in the physical type of psychic phenomena. The Committee, he stated, is concerned solely with a scientific, fact-finding effort to secure conclusive negative or positive proof regarding alleged human abilities to produce physical manifestations of communication with what is commonly referred to as the "spirit world."

The lights of the little church were left on and Dunninger and Dr. Thorne seated themselves on either side of a small table in front of the witnesses.

PSYCHIC RESEARCH

● Scientific American, in collaboration with The Universal Council for Psychic Research, offers $15,000 to any medium who can produce a spiritistic effect or a supernatural manifestation under the rules and regulations published on page 210 of our April 1941 issue. ●

"I hope," announced Dr. Thorne, "to be able to produce phenomena, and may I ask those present who are members of my developing class to please work with me, to answer any clairvoyant force, and to tell me when they see anything. I shall endeavor to make contact with those very close to me very often—Sir Arthur Conan Doyle and several others. I have here two sheets of glass, the edges of which have been bound with adhesive tape for protection of the fingers, and several plain, white cards purchased from the 5 and 10 cent store." Holding five cards aloft, one by one, and apparently turning them so that the audience could see there was no writing on them, Dr. Thorne proffered Dunninger a card, asked him to write his name thereon. This card was placed, signature side up, on top of one of the sheets of glass, which lay flat on the small table between the medium and our Committee chairman. The second sheet of glass was then laid upon the first, forming a "glass sandwich," within which reposed the card. The other four cards were offered to members of the Committee for inspection by Dr. Thorne, who stated: "No heat treatment or any other chemical solution was used in order to subsequently produce writing, and now I shall ask your chairman to tape the glass sandwich to the table so that it cannot be moved," and he handed a roll of white adhesive tape to Dunninger, who securely strapped the two pieces of glass in place. On top of the glass Dr. Thorne laid an ordinary lead pencil.

Seating himself beside the table, Dr. Thorne asked the congregation to join with him in the singing of "Abide With Me." This was followed by a few seconds of silence, during which the medium was observed to draw the back of his right hand slowly across his forehead. He then began to sing "Onward Christian Soldiers," and was joined by members of the audience.

A SECOND interval of absolute silence ensued, after which Dr. Thorne said: "I contact several spirit forces who tell me that it is their desire to present to the world startling evidence of survival after death, and that this evening the spirit of Sir Oliver Lodge will write on that card something about one of the messages you (Dunninger) have in your possession. He tells me this is the first time since his passing that this has been revealed to the world, and if you will admit that what you find on the paper is authentic, Sir Oliver Lodge will

At the request of the medium and in the presence of interested witnesses, Dunninger securely fastened the "glass sandwich" to the top of the table

return then another time and give the balance."

With this introduction, Dr. Thorne proceeded to bring vocally a number of alleged "spirit messages" to various members of the audience in much the same manner as the medium, Madame Rose Ann Ericson, had done on previous occasions, save that this time the room remained lighted and the medium gave no outward physical appearance of being in a trance-like state. The messages occupied several minutes and were apparently recognized by some of those present. Meanwhile, the glass sandwich with its enclosed card lay securely taped together and to the table in full view of everyone.

FINALLY, Dr. Thorne said, apparently addressing Dunninger, "I contact Houdini. He refers to the message in your possession and tells you to hold on tightly. Time will come when that will be presented to the world. You are a very psychic person and you may not understand, but I know that you do have a great number of impressions through spirit helpers." (In the course of his 20 years' search into supernatural manifestations Dunninger has become known as the world's foremost authority on illusionary effects, all of which, however, when performed by him, have been accomplished through the use of trickery and legerdemain. He denies that he is a "psychic" in the sense that the word is customarily applied to mediums and others who claim to have supernatural or supernormal powers.—*Ed.*)

After his message to Dunninger, Dr. Thorne paused a few seconds; then began singing "The Battle Hymn of the Republic," in which he was joined by members of the congregation. "I see," slowly remarked the medium after another brief interval of quiet, "a spirit hand over that glass. The hand is Sir Oliver Lodge's. Has anyone else seen that force?"

Several members of Dr. Thorne's developing class promptly replied that they, too, could see the hand. One man, later identified as H. P. van Walt, New York City, made the following statement: "I saw that hand. It was a light between you and Dunninger. I just saw the form—saw the force between you and Dunninger. I know it was not a human being—it was just a form."

Immediately thereafter a lady in the rear of the audience, subsequently identified as Mrs. Ramona Alexander, also of New York City, claimed she had seen the form of Houdini standing beside Dr. Thorne while he had been speaking. "I saw Houdini," she said. "I saw him. He was tall and thin, and he wore a green cape. He was holding a piece of paper with a message, but the message was not very long. It was short—only a few words."

It was evident that the climax of the seance was being attained, but Dr. Thorne made no move toward the glass sandwich. Instead, he stated: "I want all the members of my class to know their forces are helping mine. The hand is with me. My friends, will you please sing 'Onward Christian Soldiers.'"

THE hymn ended. Dr. Thorne rose to his feet, followed by Dunninger, and there was a general stir among the audience. As the medium started to remove the adhesive tape fastenings, Dunninger said: "One question—I presume that the message is upon that card. Did the spirit write it with that pencil?" (No one present had observed the pencil move from its original position.—*Ed.*)

"Not necessarily," replied Dr. Thorne.

The taping process completed, a pencil was placed on the "sandwich." Medium and some of the congregation sang while awaiting the message.

"Was that pencil used?" asked Dunninger.

"It was a substance from that pencil," answered the medium.

With that interchange, the tapes were torn off, the card was picked up by Dunninger who announced it was the one he had previously signed. "Something about 'bottle-neck'," he said, "and Sir Oliver Lodge. 'Bottle-neck' is a sign of three things in connection with the three messages. The word 'bottle-neck' is significant. You tell me what that means."

"I told you," replied Dr. Thorne, "Sir Oliver Lodge would give you a word which would mean something in connection with one of the three messages."

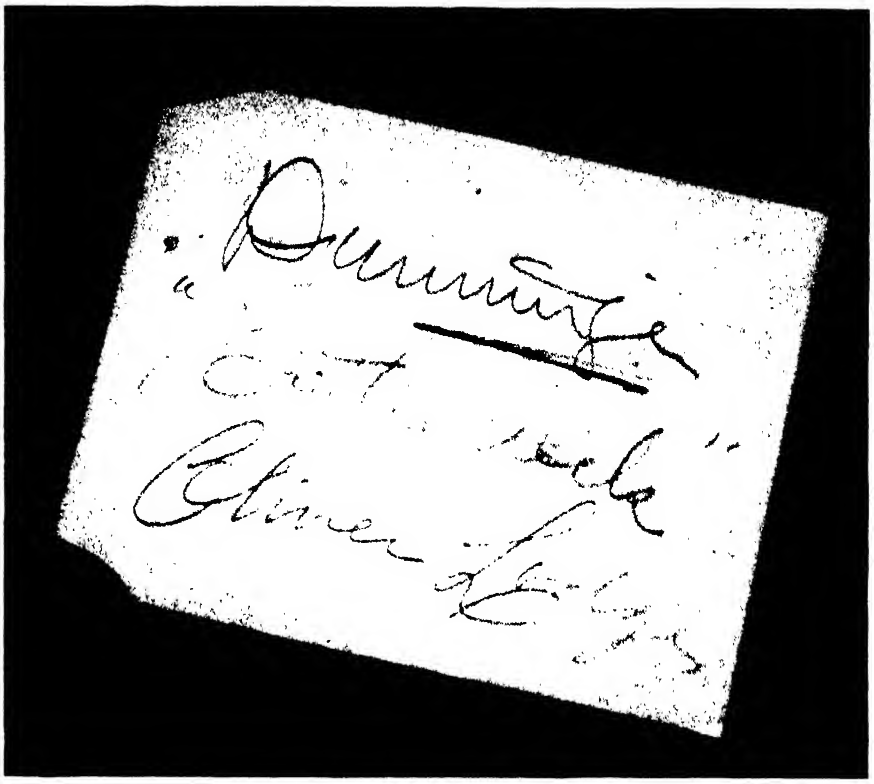
"The word 'bottle-neck' is definitely significant," remarked Dunninger. "It is *not* one of the three code messages; it is not even one of the words in the messages, but it does have a meaning, and although this is closer than anyone has ever come, I cannot give you any further information beyond that fact. And while it is an important key, I am not mystified in the least as to how the writing appeared on the card, but the word, itself, is momentous. What do you know about it?"

Dr. Thorne replied, "Sir Oliver

Card bearing message was removed, then closely examined

Lodge did that. I didn't. I haven't the slightest idea what it means, and if I can, I will get more at some later time."

Thus did the third visit of the Scientific American Committee for the Investigation of Psychic Phenomena to a mediumistic seance end. In the Committee's files are the card and the two sheets of glass, still edged with the adhesive tape, reserved for careful scrutiny



When card was removed from the sheets of glass, it bore above cryptic message, addressed to Dunninger, apparently signed by Sir Oliver Lodge

and examination at an early meeting. By way of further explanation of the rather peculiar word which had been written on the card above Sir Oliver Lodge's signature, Chairman Dunninger stated that in connection with the three code messages in his possession the word "bottle-neck" does not have the same interpretation that is popularly attributed to it in national defense preparations today. "Rather," he said, "it is a word well known to magicians as being descriptive of a certain type of handcuffs, and could readily be associated in the mind in connection with Houdini."

In accordance with the rules governing the search for the truth concerning psychic phenomena of a physical nature, it now becomes necessary that Dunninger "duplicate or explain through natural or scientific means" the actual production of words on a previously endorsed card during its insertion in a glass sandwich similar in every respect to the one used by Dr. Thorne in his manifestation. However, it is not required that Dunninger produce the same words, but merely that he duplicate the physical part of the performance, and in the event the so-called phenomenon is duplicated by natural or scientific means, the requirements originally established to govern the activities of the committee will have been complied with.

Interest of Readers

As foreseen by the editors of Scientific American and so announced in our April issue, mental distress and uncertainty of all peoples has been enhanced by the world's war-like attitude, by international economic and social unrest, with the result that man's age-old query of what lies ahead next week, next year, brings about a dangerous public trend toward futility, and a tendency to turn to so-called mystic rites of cults or individuals in a desperate attempt to find the answer to the future. Since the publication of our April issue, letters have been received from all parts of this country, from Mexico, and from South America. Some implore our Committee to assist in solving "puzzling experiences;" others request an interpretation of a vision or a series of dreams which apparently foreshadowed a coming event; still others were written in praise or condemnation of our efforts to find some grain of scientific truth which could conceivably link unexplained episodes to some hitherto unknown but suspected psychic force.

A Bottle-Neck Breaker

Welding Presents Advantages of Speed and Low Cost to Machine Tool Industry

ED C. POWERS
Assistant Secretary,
The James F. Lincoln
Arc Welding Foundation

ELECTRIC arc welding is bringing to the machine-tool industry—that vitally important base upon which is being built the program of production for national defense—two outstanding groups of advantages. First, machine-tool builders have available, in the welding process, a proved means of producing tools in shorter time and at lower cost than by other methods, with the added desirable feature of lighter weight. Second, when machine tools are fabricated by welding, a substantial reduction can be made in the amount of machining required on tools of all types.

With these two groups of aids to production, the manufacture of lathes, punches, shears, broaches, milling machines, and so on can be stepped up to a point where there should be no outstanding difficulty in producing the $450,000,000 worth of equipment per year which is currently considered to be necessary for our own defense demands, and for the war needs of England and Canada.

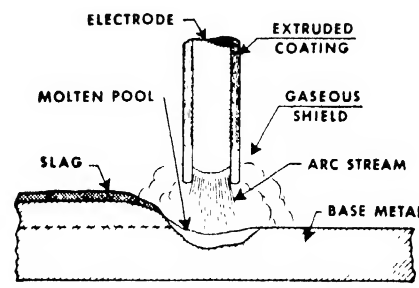
Substantial proof of the advantages of welding in machine-tool building are given in Tables 1 and 2, compiled from actual case studies reported by designers, engineers, and others. In the first table are shown examples of the savings that welding can make in matters of time, machine weight, and cost; in the second are figures on savings that have been made in machining time—and hence cost—in finishing the ultimate product.

The manner in which welding makes possible these advantages to the machine-tool industry, and to other industries where products, machines, and structures are made of metal, is simple yet fundamentally sound. The older and perhaps more conventional method of producing the strong and rigid units which make up the great majority of machine tools, was to cast the required parts in cast iron and then assemble these parts by riveting or bolting. This procedure, of course, required time-consuming pattern-making, extensive machining of the cast parts, and expensive final assembly.

When welding, on the other hand, is applied to similar production problems, the machines and structures are built up of standard rolled steel as purchased from the mill. Cutting the steel to the sizes needed, assembling the various parts, and fusing them directly together without extra operations are features of the welding process. Here there is no need for such patterns as are used in casting, or for punching, drilling, and extra connecting members as in riveted construction.

SINCE steel is used in welded machine-tool production, reduced weight and lowered cost are obtained because the steel employed is two and one half times as rigid, four times as strong, and costs only 30 to 40 percent as much as cast iron.

Essentially, arc welding consists of merely forcing a powerful, though harmless, electric current to jump a gap between an electrode and the metal to be welded. The current is carried from the arc-welding generator by rubber-covered wire cables, one of which is connected to the electrode, and the other to the work metal. When the electrode is touched to the metal and drawn away a fraction of an inch or so, the arc so formed generates an intense heat—approximately 6500 degrees, Fahrenheit—which melts both the end of the electrode and the work metal. The molten metal from the tip of the electrode flows to the molten spot on the parts being welded. When these mingled and melted metals cool, the parts are welded together and have become essentially one solid, single piece. And this piece is actually stronger in the welds than anywhere else. This is because of the superior qualities of modern weld metal, as compared to rolled steel, due to the exclusion of oxides and nitrides from the metal as it is deposited. This exclusion is accomplished by a gas which is produced as the coating of the electrode is consumed in the heat of welding. This gas surrounds the molten metal and shields it from the atmosphere, giving the name "shielded arc" to



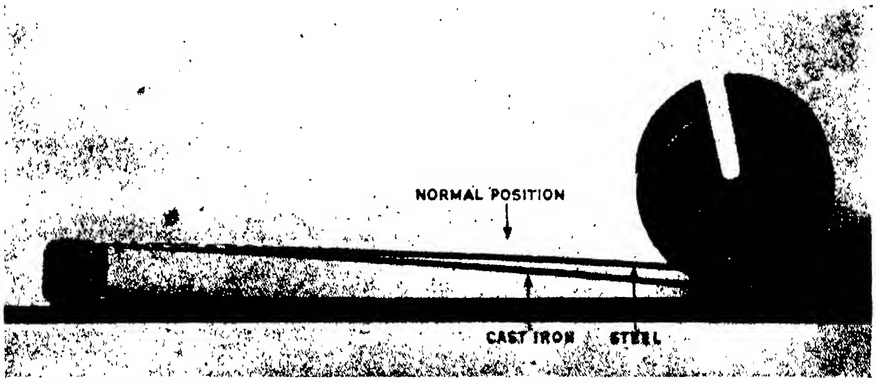
Atmospheric oxidation is prevented by "shielding the arc"

TABLE I
Time, Weight, and Cost Comparisons of Machine Tools Produced by Casting and Welding

MACHINE TOOL	CAST IRON			WELDED STEEL		
	Time	Weight	Cost	Time	Weight	Cost
700-Ton Metal Forming Press	90 days			35 days		
Boring Mill		70,952 lbs.			60,000 lbs.	35-40% less
Shaft Roll Forming Machine			$ 1,045.86			$ 688.13
Planing Machine		134,400 lbs.	6,286.00		98,900 lbs.	4,925.05
Riveting Machine	5 mos.	9,500 lbs.	1,554.28	3½ mos.	8,400 lbs.	902.99
High-Speed Metal-Forming Machine		11,200 lbs.	2,104.00		6,835 lbs.	908.00
Saw		900 lbs.			600 lbs.	
Rotary Planing Machine	18 mos.		12,879.00	2 wks.		5,200.20

modern welding. This one favorable factor of arc welding—that it attains the full advantage of steel throughout a welded structure—is shown in Table 3 where comparisons are made between properties of weld metal and rolled steel.

But even with the advantages of welding that have been outlined, the process would not be able to enter the production picture if the material with which it is used did not peculiarly lend itself to the job in hand. Machine tools, designed to turn out precision work and to continue with the same degree of accuracy for thousands and often millions of operations, must of necessity have ample margins of rigidity and strength. Without maximum rigidity, parts will bend under stress and cause inefficient and faulty operation; without maximum strength, the machine will be unable to sustain the loads put on it.



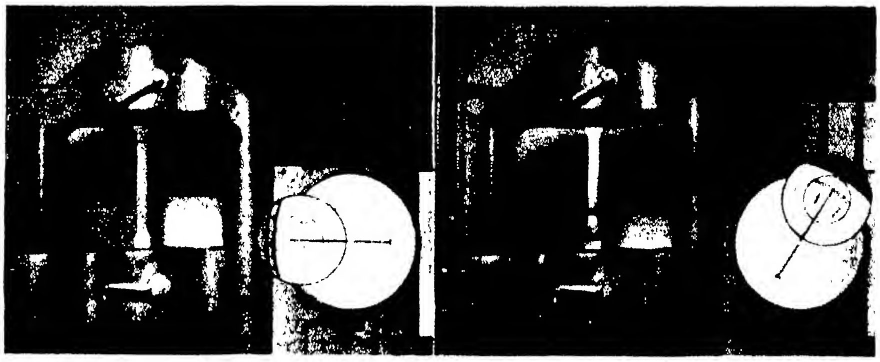
Rigidity test deflects iron bar two and one-half times more than steel

TABLE III

Properties of Weld Metal and Rolled Steel

Material	Tensile Strength Lbs./sq. in	%Elongation in 2" (Rigidity)	Density Grams per c.c.	Endurance Limit Lbs./sq. in.	Notched Bar Ft. Lbs. (Impact)
Mild rolled steel	55,000-65,000	20-30	7.86	24,000-28,000	20-80 (Izod)
Modern weld metal	65,000-75,000	20-35	7.84-7.86	28,000-32,000	25-80 (Izod)

PERHAPS the comparison of these two qualities, particularly that of rigidity, in steel and cast iron is not fully appreciated. It is frequently thought that, of the two, cast iron is the stiffer; that is, more resistant to bending. The actual facts in the matter, however, are brought out by a simple test of rigidity. This test consists of attaching two rods, one of cast iron and one of steel—equal in length, width, and thickness—to a block so that the ends are free to move. When equal weights are placed at precisely the same positions near the ends of the rods, it will be found that the cast-iron rod will bend $2\frac{1}{2}$ times more than the steel. In other words, under equal load, steel is deflected only 40 percent as much as cast iron.



Tensile tests indicate breaking points: iron bar on left, steel on right

The greater tensile strength of steel in comparison with ordinary cast iron is an acknowledged fact. Just to complete the comparison, however, it may be stated that when two equal size bars, one of steel and the other of cast iron, were tested to destruction in a tensile testing machine, the steel bar withstood a stress of 61,800 pounds per square inch, while the cast-iron bar broke at only 16,420 pounds per square inch.

Also important in the construction of machine tools are the factors of fatigue and of resistance to shock and impact. In fatigue resistance, steel is three times better than ordinary cast iron; its resistance to shock and impact is many times greater.

The reduction in the amount of machining required on finished products produced by welding, as compared with those produced by casting methods, may be explained in this way: Since steel has qualities of strength and rigidity in excess of cast iron, only a fraction

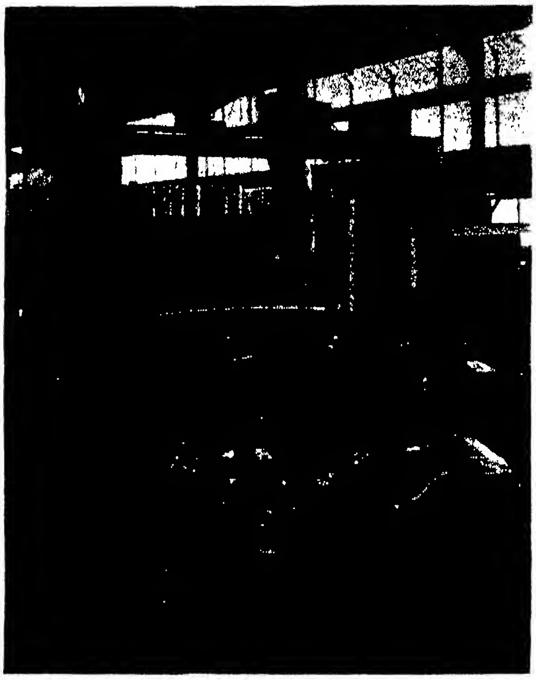
TABLE II

Savings in Machining Time and Cost on Various Products of Welded Construction

PRODUCT STRUCTURE OR PART	MACHINING TIME AND COST				MACHINING SAVED BY USE OF WELDED CONSTRUCTION		
	Former Construction		Welded Construction				
	Time (hr)	Cost ($)	Time (hr)	Cost ($)	Time (hr)	Cost ($)	%
Deep Well Pump	40	32.00	24	19.20	16	12.80	40%
Bulldozer Die for Tractor Steer Rod	21	16.66	19	14.90	2	1.76	9½%
Boring Fixture	54	43.12	45	36.25	9	6.87	16½%
Locomotive Guide Yoke	26	20.62	20	16.00	6	4.62	23%
Metal Cutting Machine	19	15.00	12	10.00	7	5.00	37%
Dust Collecting Bench	65	51.63	35	28.38	30	23.25	46%
Copper Sheet Coiling Machine	160	128.00	128	102.00	32	26.00	20%
Die Cutting Press	244	195.00	206	165.00	38	30.00	15½%

NOTE:—Figures based on the present rate (80c per hour) for skilled labor in the machine tool industry.

as many pounds of steel are required in a given machine to obtain equal strength (Table 1). Obviously, the amount of machining will in general be in proportion to the amount of metal used. With half as much metal, or even less, it will naturally follow that only approximately half as much machining will have to be done. Furthermore, since welded structures are built up of standard rolled steel shapes cut to correct sizes to meet design requirements, there is little or no excess metal to be machined.



Arc welding reduced weight of this boring mill 15 percent; cut costs about 40 percent

In the words of an engineer in one of the country's largest manufacturing plants: "Each of the two methods formerly used in machine part construction, casting and riveting, had one very desirable property. The former, at its best, produced a homogeneous structure, but in the case of iron castings the metal is of relatively low tensile strength, having little resistance to impact or fatigue stresses, while steel castings present technical difficulties so great that soundness in complicated forms is seldom attained. If the advantages of the two processes could be combined in one method of construction and the resultant product sold at competitive prices, it would be an outstanding accomplishment. Arc welding does this, taking rolled steel in either plate or structural forms, joining the pieces together as they would be in a casting and fusing the various members into a structure of uniform physical properties by the use of high strength, ductile steel as a joint metal. The product can be sold for the same or somewhat lower price than that built by either of the older methods, leaving a greater margin of profit to, in turn, permit the manufacturer to provide improved service for his customers."

Following are some opinions of executives, engineers, and designers in the machine-tool industry regarding welded construction:

Designer of Rotary Planing Machine: "Many as are the benefits which industry and the community have derived from the use of welding, one of the most important is the opportunity it has afforded of rapidly supplementing production of the whole or part of essential machines when the branches of the industry which had specialized in these were found incapable of meeting the demand for their products."

Chief Engineer of Planer Manufacturing Company: "On the basis of approximately $6,000,000 worth of planers sold in a normal year, the industry would realize a saving of at least $1,200,000 in purchasing power alone. Added to this would, of course, be the continual saving of power, and the initial saving of freight and foundation costs."

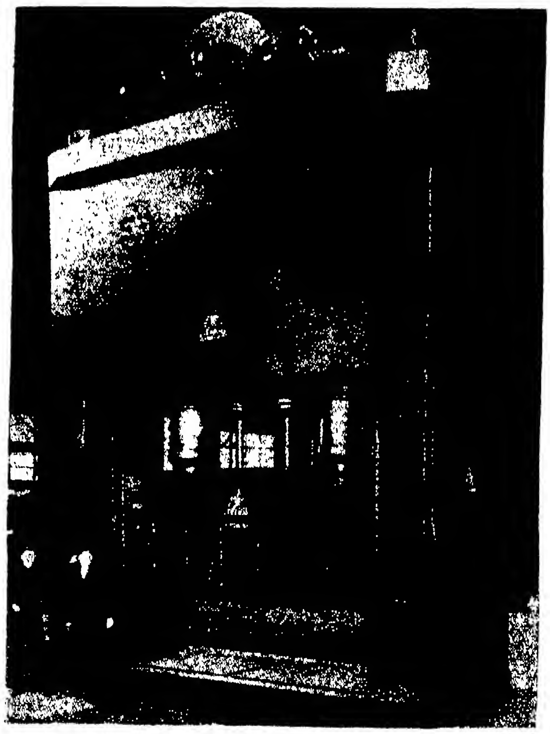
President of Company Making Band Saws: "It is interesting to observe that we launched this new line of arc-welded machines during the depression. Because of the lower price and larger capacity, these new models are actually solving an acute problem for us in getting a profitable volume of business."

Chief Mechanical Engineer, Machine Tool Builders: "The welded machine can be designed more efficiently than the cast machine. In the latter type, the material has to be increased at certain points in an endeavor to have the thicknesses as uniform as possible. In the welded machine the material need be no thicker than required to develop the stress."

Designer of High-Speed Metal Forming Press: "The time element plays a very important part in the construction of most presses. When prompt delivery of a machine is required, welded design offers another distinct advantage over the cast method of construction. In most cases the time that would be required to produce the necessary patterns for a cast product is more than ample to cover the welding time on the job."

Some machine tool builders still have the opinion that the arc-welding method of production is fine for special machines but for mass production it can't equal castings. They hold to this opinion because they have their patterns made and their whole production geared to the idea of cast construction. But builders who have utilized arc-welded steel to the full extent of its efficiency say: "It doesn't matter whether you're building 1 or 1000; you can produce them faster and at less cost by welding!"

These extreme views can be accounted for by habit—the accustomed way of doing things—which



Giant press, built by arc welding process

is the most important factor in resistance to adopting welding for certain jobs.

Success in the use of welding is chiefly a matter of design. The importance of this is expressed as follows by the president of a nationally known company:

"It is only through having the courage to depart from past experience and training that welded design can succeed. The writer has experienced instances in his company where attempts to redesign cast details for welding have failed nine times, but the tenth try resulted in a design highly successful, from both the standpoints of efficient operation and reduction in cost. The promises of revolutionary design in castings is remote, but, with welding, the opportunities are unlimited. All that is needed to insure success is inspiration, imagination, creative thinking, and the will to pioneer."

In order that the benefits of modern arc welding may be fully appreciated and more speedily attained, an award program offering 458 awards, totaling $200,000, is being sponsored by The James F. Lincoln Arc Welding Foundation. Speeding up production is an important factor of judgment for the Foundation awards. Also, machine tools, both metal cutting and metal forming, are definitely designated as subjects for awards in two principal divisions of participation. Lathes, broaches, milling machines, planers, and all other machine tools are covered.

Considering the spectacular industrial developments brought about by application of data from studies in the Foundation's previous award program, it is expected that the current program will stimulate further advances. Previous studies, principles of which are now being employed by leading manufacturers, have speeded up production of machine tools and countless other products by as much as 30 percent.

• • •

PORTABLE SUBSTATION

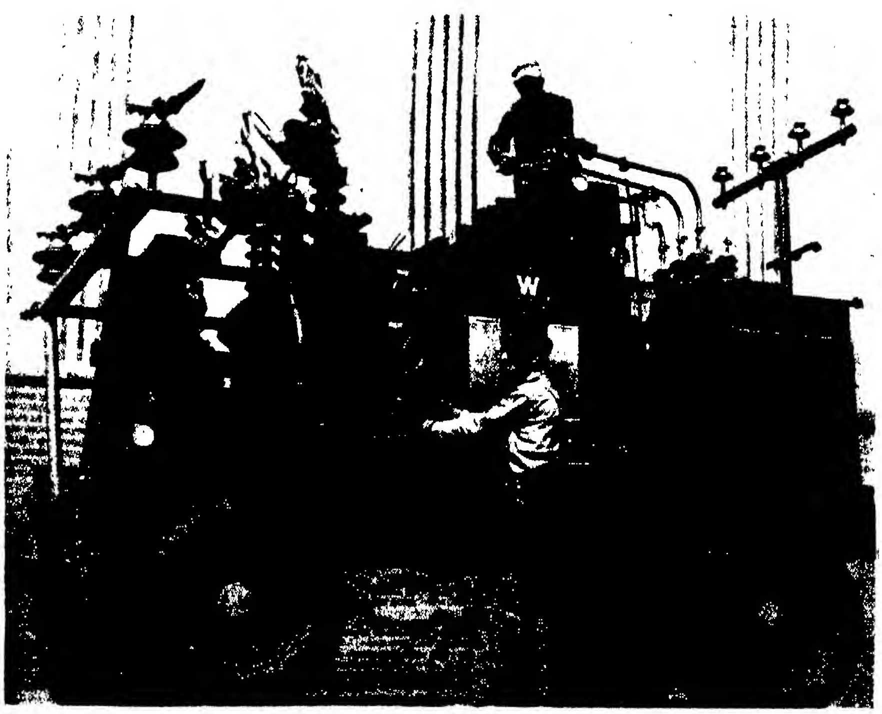
Transformer on Wheels for Emergency Use

OUT of the Westinghouse plant recently rolled a "power guardsman" on wheels, ready to keep electric power flowing to national defense industries, hospitals, and homes. Built for the Cincinnati Gas and Electric Company, this mobile substation is essentially a transformer that can restore power quickly if a regular substation should break down. Transformers are the necessary distribution links between high-voltage lines and factories or homes, reducing voltage to usable stages.

If the lights in a city go out because of trouble developing in a regular substation, a power company can speed a trailer unit to the scene and "plug in" to the power line, restoring power in a short time. The four-wheel trailer carrying the mobile substation can be towed on a highway at speeds up to 40 miles an hour.

Portable units can also be substituted for permanent substations which are shut down for inspection or maintenance work. Another use is supplying power for construction work. One of these substations can take power from a 33,000 volt line and step it down to 4500 volts, or the same unit can transform 13,200 volt power to 4500 volts.

Heart of the portable substation is a compact transformer in which the core and coils are laid on their side and cooled by forced oil circulation. This transformer is an outgrowth of one which was developed several years ago to fit into the small space of an electric locomotive. The new portable transformer is about one fifth as large and weighs three fifths as much as a permanent substation unit of the same rating.



A complete transformer substation on wheels

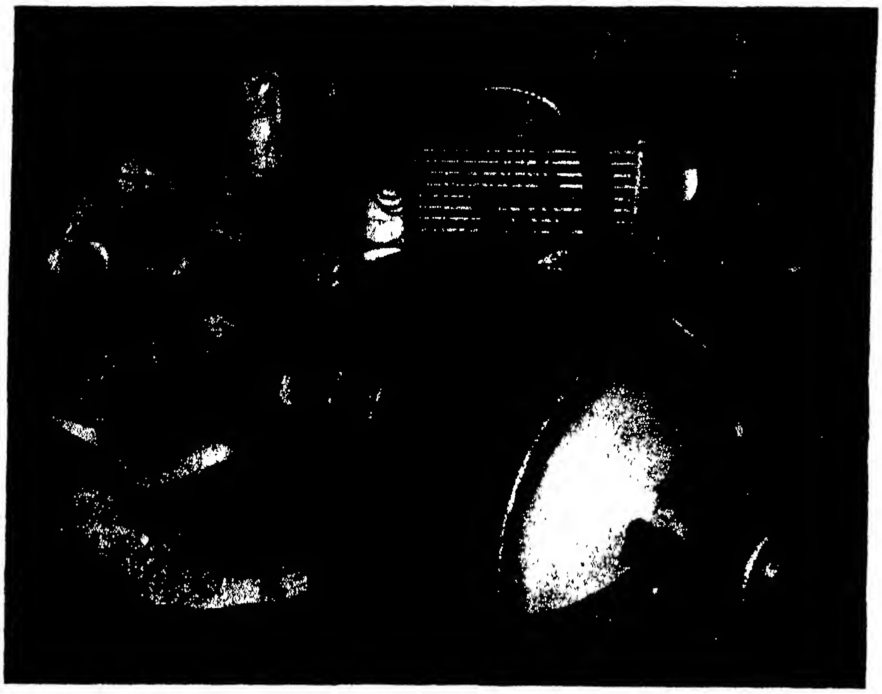
PROTECTION

New Standards To Benefit Industrial Workers

BETTER protection for workers from the hazards of toxic dusts and gases in many industries is foreshadowed in the completion of three new standards by the American Standards Association. One of these sets safe limits for the amount of hydrogen sulfide in the air of factories and other workplaces. Another covers carbon disulfide, and a third benzene.

The need for some standard method of determining permissible concentrations of these and many other dusts, fumes, mists, vapors, and gases used commercially, has been recognized for a good many years. For example, a tremendous amount of research has gone into bringing the amount of carbon monoxide given off by gas ranges and other gas burning appliances down to safe limits.

These three standards which have just been completed, and a fourth covering allowable concentrations of carbon monoxide, are



Portable X-ray unit for industrial use is aimed like a gun

part of an ambitious program to set safe limits for every toxic substance that presents a serious industrial health hazard. The limits set forth in these three standards were arrived at after a careful study of all previous work in the field, reinforced by the experience of the members of the committee in charge which represents 12 national organizations interested in industrial health problems, and the U. S. Department of Labor. Wide industrial participation in the work ensures that the limits set are not merely medical or physiological limits but can be maintained by industry without undue cost.

Hydrogen sulfide, the subject of one of these new American Standards, is familiar to most people as a colorless gas having an offensive odor, as of rotten eggs. Exposure to it causes irritation of the entire respiratory system and of the eyes. In high concentrations it may produce respiratory paralysis and damage to the nerves. This gas occurs naturally in the gases of volcanoes and in the water of certain spas. In mines, it is frequently produced by the decomposition of pyrites and it is present in certain sulfur-carrying brands of coal oil. It is formed wherever protein-containing materials are rotting, as for instance in tanneries, in the manufacture of glue, the washing of sugar beets, and in sewer gases. Hydrogen sulfide is very widely used in the chemical industries, in the manufacture of rubber, and in the manufacture of rayon. The newly completed American Standard sets as the maximum allowable concentration of this gas, 20 parts per 1,000,000 parts of air for exposures not exceeding a total of eight hours daily.

Carbon disulfide, the subject of the second new American Standard, acts as a narcotic in high concentrations, and in low concentrations with prolonged exposure results in cases of severe general nerve poisoning. Its removal presents a serious problem in the rayon industry. It is also used as a solvent for sulfur, fats, oils, and so on, and in the manufacture of carbon tetrachloride, camphor, and of rubber and other waterproof cements. The newly completed standard recommends that concentrations of carbon disulfide be kept below 20 parts per 1,000,000 parts of air for general factory and workroom purposes.

Benzene, or benzol, is the subject of the third standard. It is a toxic substance which acts predominantly as a nerve poison, causing depression of the central nervous system; and, with chronic poisoning, damage to the blood, the blood forming organs, and the blood vessels. The newly completed standard provides that the maximum allowable concentration of benzene (benzol) shall be 100 parts per 1,000,000 parts of air for exposures not exceeding a total of eight hours daily.

For Information on New Products and Processes, See the Section

Industrial Growth

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MILLION VOLT

New Industrial X-Ray Unit Is Portable

A MILLION-VOLT X-ray unit weighing 1500 pounds is capable of making pictures through an inch of steel at snapshot speed. If necessary the entire unit can be moved to the scene of operation to study structural supports of bridges or steel foundations of buildings.

BLUE GLASS

Increased Protection and Greater Visibility for Welders

A BLUE glass compounded to filter out injurious rays of light in conditions of excessive glare is now being used in welder's lenses specifically recommended for aluminum and bronze welding. The lenses are also suitable for use in other occupations where a sodium yellow glare is encountered. This glass, called Alubro-Weld, is a recent development of the Willson Optical Research Laboratories.

Welders on aluminum and bronze can far better see their work through Alubro-Weld lenses, it is claimed. Hence the flow of metal onto the weld can be more accurately controlled.

REFLECTORS

Chromium-Plated Copper Substituted for Aluminum

IN co-operation with the national defense program to conserve aluminum, chromium-plated copper is being substituted by various manufacturers. It is stated that, of all the possible substitute materials for reflecting surfaces on sodium luminaries, chromium plated over nickel plating on copper provides the most satisfactory result.

INDUSTRIAL TRENDS

CHEESE . . . AND CHEESE

CHEESE may be only that final touch which, to the connoisseur, hails the end of a perfect meal; to those in the industry it is a commodity which may be seriously affected by world conditions. So it is that, today, the entire cheese industry finds itself in a state of change, brought about by World War II.

Importation of such foreign types of cheese as Roquefort and Camembert ceased abruptly when France was occupied by the Nazis; cheese of Italian origin, such as Gorgonzola and Bel Paese, are now difficult to obtain. Consignments of cheese from Switzerland have, of course, been affected by shipping difficulties, and Canada has forbidden exports of Cheddar and other types except to the British Isles.

It is not to be expected, however, that those in the cheese business in the United States have taken these setbacks without attempts—and apparently successful attempts—to build for themselves a domestic industry that will not only replace the foreign sources of supply but will eventually create an American cheese-producing group which will supply world markets with cheeses second to none.

Domestic "Swiss" cheeses have been on the market for some time and, in some quarters, are considered to be equal, if not superior, to those imported from Switzerland. The same is true of Camembert and Liederkrants, Brie and Limberger. It is in the Roquefort type, however, that present progress is being made and in which cheese producers are the most interested. This "*bleu*" cheese cannot, because of restrictions placed by the Roquefort Association of France, be called "Roquefort" when produced elsewhere than in France. Regardless of name, however, the flavor is there in American *bleu* cheeses, even though, in some cases, it is made from cow's milk instead of the goat's milk that produces the "genuine" Roquefort. Aging methods, so essential to the ripening of this cheese, are being developed in this country, and underground caves are being built in various localities, especially for this part of the process.

PICTURES FROM THE AIR WAVES

ALTHOUGH the television industry in the United States appears to be on the edge of a boom, triggered off by the final consent of the Federal Communications Commission to permit commercial operation, it is still too early to forecast a wide-spread trend. Frequency modulation has now entered the picture and, at the time of writing, it is pretty definite that this system will be used for transmitting the sound accompaniment for television pictures. This, of course, will make necessary major operations on, if not complete replacements of, those television receivers already in the hands of the public. Then, too, the national defense program looms large, taking precedence in essential materials that are necessary both to its needs and to the construction of television receivers. Thus any large-scale production in this field may be a long time coming, despite the enormous technical strides that have been made in the laboratories where television has been gestating for years.

TIN FROM TIN CANS

TIN, that strategic material of war which also protects so many of our foodstuffs from the corrosion of sheet-iron cans, is the subject of much speculation today, both financially and mentally. Why not reclaim the thousands of pounds of tin that daily are coated on sheet-iron which, in turn, is formed into the familiar tin cans? This is a question that is often asked, the answer to which, eventually, may have to be used to solve a really acute shortage of the metal. At the moment, however, and until such time as financial considerations are overbalanced by need, the question may be answered simply: The process is too expensive.

As the tin situation now stands, and as it has stood for some time in the past, it is cheaper to throw away used cans and to fill requirements from new stocks. It has been estimated by a committee of the National Academy of Sciences that 12,000 long tons of tin—about one eighth of our national needs—could be recovered annually from tin cans used in the United States. But, adds the committee, the over-all cost of recovery would be high.

Many are the processes that have been proposed for reclaiming this bright metal which plays such an important part in our national economy, but so far none of them has proved practical from every standpoint. When one does come along that fills the bill, it will have a virgin field to work; in the meantime, or until the pinch of necessity forces recourse to expensive processes, city, town, and village dumps will continue to be the final resting place for millions of pounds of tin.

HERE COME WELDED SHIPS

SOME 15 years ago the United States Navy started experimental work with welding for the fabrication of the hulls of vessels; since then this process has been applied to a variety of small craft and to tankers and freighters. Now, by the time this is being read, there will be afloat the first all-welded passenger ship ever built—the *African Comet*, scheduled for launching sometime in June.

Briefly summarized, the advantages to shipbuilding of welding are smooth contours of the hull, which decrease water resistance, and a saving of some 13 percent in hull weight. These two features go hand-in-hand to increase the carrying capacity of a given vessel and to increase her speed, decrease cost of propulsion, or both.

The trend toward speedier merchant ships is thus being assisted by the application to the ship-building industry of technical advances in welding. Soon the *African Comet* and two sister ships will be plying between the United States and Africa, in general cargo and passenger service, linking New York and Capetown in 16½ days, nearly a week faster than the fastest schedule now being maintained. One important duty of these ships will be transportation of vital supplies of chrome and manganese.

—*The Editors*

Wartime Astronomy

A Mere War Does Not Sidetrack European Astronomers from Regular Work

HENRY NORRIS RUSSELL, Ph.D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

NEWS of the activities of astronomers on the continent of Europe is more than ever welcome when it comes through in these days. Among the last to be received come new numbers of the *Publications* of the Observatory of the University of Tartu. The Soviet stamps on the envelope show that no diplomat would now refer to this city as Esthonian; but the contents of the publications show that our colleagues there, Dr. Öpik and his assistants, are still actively at work. Most of the individual papers are in English; the rest in German. All are of interest to professional astronomers, and some deserve a wider attention.

There is a discussion, for example, by Dr. V. Riives, upon the old but still mooted question whether the changes in terrestrial climate which are indicated by the recurrent ice-ages can be explained by the passage of the solar system through a cosmic dust-cloud which cut off part of the Sun's heat.

There are plenty of such absorbing clouds in space, but most of them are composed of haze so thin that light which had traversed it for a whole light-year is weakened by much less than half. If the Sun, with all the planets, were immersed in such a cloud, the heat carried by its direct beams would be weakened by a very few parts per million. If the change could in some fantastic manner be effected over night, we would find the sky a little brighter, perhaps as if illuminated by faint moonlight, with a stronger glow visible in the east before sunrise and in the west after sunset — as the zodiacal light is now. If the great cloud extended far enough, all the stars in the heavens would seem dimmed, and astronomers would find a large part of their occupation gone. But none of these changes would affect climate by a thousandth part of the least discernible influence. To weaken the Sun's heat enough to produce geological changes would demand an absorbing cloud more than 10,000 times as opaque.

Nothing of this sort has ever been observed in inter-stellar space. We would probably miss one, even if it lay in front of a bright part of the Milky Way, provided it was small enough — say less than 100,000,000,000 miles across. But the solar system, moving as it does in space, would pass through a cloud no bigger than this in a few centuries — too rapidly to produce geological effects.

EVEN if the Sun overtook a cloud moving almost at the same rate, and remained inside it for thousands of years, the Earth would experience no ice-age. Dr. Riives points out that even a dense cloud of matter between us and the Sun would not diminish the heat which the Earth receives. The outflow of heat from the Sun depends on conditions deep inside it, and would be quite unaltered by any external cloud. And the flow of heat must ultimately escape from the cloud itself, otherwise the cloud would get hotter and hotter. Draw a sphere centered on the Sun, and as big as the Earth's orbit. The heat produced by the Sun will all pass out through this sphere. Some of it may have been caught by particles in the cloud, heating them up, but this would be re-radiated and, at one or more removes, would ultimately escape through the sphere. So our planet, on this sphere, would get as much heat per day as before from the Sun and the cloud together.

This is what would happen if the absorbing cloud filled this sphere and went no farther, leaving clear space outside. But if it was larger — say as big as Jupiter's orbit — its presence would make the Earth hotter. The particles in the shell beyond the Earth would themselves be heated by the outgoing radiation, would be warmed, and send out heat, both outward and inward. The outgoing stream might escape; the ingoing flux would in part be trapped by particles inside the Earth's orbit, and relayed once more. When a steady state was reached, our sphere would have heat flowing into it from the outer parts of the cloud and flowing out through it from the inside; and the net balance would amount to an outflow equal to the heat-production from the Sun at the center. The total amount of heat caught by the Earth, or by any other test-body, would thus be increased — not to mention the additional heat supplied to it by those particles which actually fell into the atmosphere.

Hence an obscuring cloud in the solar system would not cool the Earth, but might make it hotter. The only possible escape from this, according to Dr. Riives, would be to assume a cloud of particles moving so fast that they got far away from the Sun, on the "lee side," before they could cool. But calculation shows that this demands conditions which are absurd in practice.

One possibly attractive explanation of glacial periods is thus eliminated, and a new and amusing addition made to the list of real paradoxes.

ANOTHER good communication deals with the velocities of meteors. Dr. Öpik, its author, spent months in Arizona, in 1931, observing the paths and velocities of these tiniest of celestial objects, and has continued his studies in Esthonia since his return.

To find the real path of a meteor we must have observations of its apparent track among the stars from two stations, 20 or so miles apart. It then requires merely a little trigonometry to work out the actual path in the upper stratosphere.

The most accurate records, by far, are photographic: but these have two disadvantages. First, meteors streak across the sky so fast that only the brightest — brilliant objects to the naked eye — leave a trace on the plates. Second, these bright meteors are of rare occurence, so that only one meteor-path will be found, on the average, on hundreds of plates.

It would be a heart-breaking waste of time and money to photograph the sky simply in the hope of getting a meteor once in a while. But the regular "sky patrol" at Harvard, in which the whole available part of the heavens is photographed, field by field, many times a year, for the sake of the permanent record, catches many bright meteors incidentally. The two stations at Cambridge and Oak Ridge, 23 miles apart, form an excellent baseline, and by planning the program so that cameras at each station are simultaneously pointed toward the same region in the high atmosphere, a good many doubly observed trails have been secured. By placing a rotating shutter, comparable to a very narrow air-propeller rotated ten times per second by a synchronous motor, in front of each camera, the meteor may be timed as well as surveyed and its velocity found. Dr. Whipple, working up a number of such observations, has found that a large majority of these bright meteors were moving around the Sun in elliptical orbits of small inclination and rather short period, like those of the short-period comets. These bodies are evidently members of our solar system, and might fairly be regarded as minute stragglers from the great swarm of the asteroids.

For fainter meteors which "go by too fearfully quick" to be photographed, the paths in space can still be found with fair precision if each of two observers has carefully plotted the apparent track of the meteor among the stars, immediately after seeing it. But to get the speed is much harder. Few of us are trained to estimate, even very roughly, the duration of an unexpected phenomenon which lasts a few seconds, or less.

But even the best observer may not spot the meteor at the very first instant it appears. A mechanical aid, invented by Dr. Lampland of the Lowell Observatory, consists of a mirror, mounted on supports in such a way that it makes a small oscillation 10 times per second. The image of a fixed star, seen in such a manner, will be drawn out by the familiar persistence of vision into a small circle. That of a moving meteor will appear not as a straight, but as a wavy track, each wave corresponding to a tenth of a second.

It takes some care to learn to observe accurately with this device, but the observers at Flagstaff, and later at Tartu, have succeeded excellently by placing a reticle of wires beyond the mirror and between it and the sky. As seen reflected from the observing point, the wires divide the sky into squares nine degrees on a side. By noting the number of waves in the part of a trail which crosses a given number of squares, the apparent velocity of the meteor's flight in degrees per second was found.

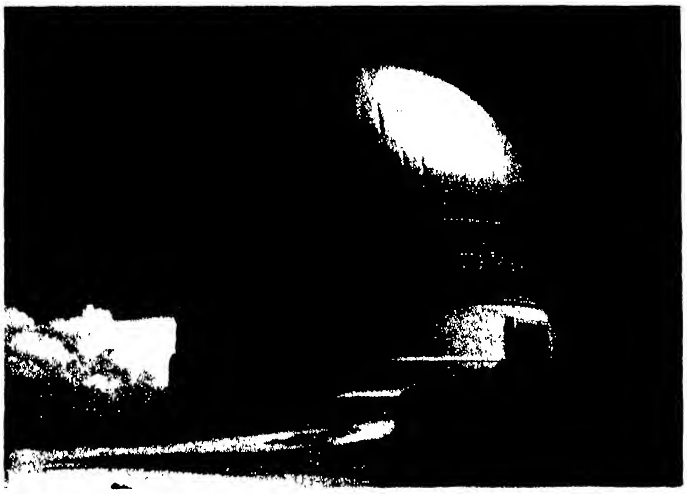


Photo by Major Martin D. McAllister

It awaits the 200-inch mirror at Mt. Palomar, whose date of completion is known to no man (unpredictable)

Öpik's memoir gives details for 406 observations in Arizona, and 380 in Esthonia. For the latter, no observations at a second station were available, so that the distances of individual meteors could not be calculated There were, however, a large number of meteors belonging to known showers. For these, the real velocity relative to the Earth is known. The mean height at which they appear was furnished by the Arizona observations, and the angular velocity with which a meteor observed at a given place in the sky and at a given hour *ought* to move, can be calculated. In this way the observations could be checked, and certain corrections applied.

For about one third of the meteors, the duration of flight was not measured with the rocking mirror, but simply estimated. The discussion showed that Öpik's estimated lines were nearly as accurate as those found by the mirror, but a couple of other observers, not previously trained in precise observation, did pretty well with the mirror, while their direct estimates were wild.

For the general run of the sporadic or non-shower meteors, the observed velocity transverse to the line of sight was then calculated. To make allowance for the effect of motion toward or from the observer, so as to get the velocity in space relative to the Earth; to pass from this to the velocity relative to the Sun; and to correct the results for the inevitable error of observation, was an intricate task whose description occupies many pages of mathematical argument which our readers may thank us for skipping.

The final results show that these faint meteors are very different from the bright fireballs. Between 75 and 80 percent of these have such high velocities, relative to the Sun, that their orbits are hyperbolic, showing that they are intruders into the solar system from interstellar space. About 15 percent have velocities comparable to that of the average comet and appear to be revolving about the Sun, but in highly elongated orbits of long period, while the proportion of short period orbits is 10 percent or less.

This remarkable conclusion is not new, but confirms, with a higher degree of security, results reached by several earlier investigators.

How these innumerable tiny specks of matter got into interstellar space no one knows; maybe they "were always there."

Once, at least, according to astronomers' gossip, Harvard cameras caught something different. A beautiful straight trail was found on two plates taken by telescopes a few yards apart. On superposing the negatives, there appeared a quite definite shift which indicated that the altitude of the moving luminary was about 1,000 feet. All the data indicate that it was a green starboard light; the red port light did not record itself on the plates.

Radio Runs a Transit

Accurate Ocean-Floor Topographic Maps Made Through Acoustical Surveys

CAPTAIN GILBERT T. RUDE
United States Coast and Geodetic Survey

MODERN science has fostered revolutionary improvements in instruments and technique for sounding the ocean's depths with ease and accuracy, as well as for determining with increased precision the geographic positions of the soundings. The hydrographer of today invades the shop of the radio engineer for his equipment, and searches the laboratory of the physical scientist for his methods. As a result he is able to extend co-ordinated surveys hundreds of miles offshore and to make accurate hydrographic surveys of such features as the Atlantic Ridge, accomplishments quite impossible a decade ago.

Ocean surveys made by echo sounding and controlled by radio-acoustic ranging, the new method developed by the United States Coast and Geodetic Survey for determining the positions of soundings, have disclosed a wealth of dissected underwater topography — submarine gorges along the continental shelves that rival the Grand Canyon, submerged mountains rising to towering heights, and huge trenches that form the great ocean deeps.

Echo sounding is almost self-explanatory. Depths are determined by measurement of the time required for a sound impulse from an electric oscillator to travel to the ocean floor and to return as an echo to a hydrophone in the ship's bottom. This time interval is automatically measured and converted to depths by a "fathometer," an instrument of extreme accuracy, constructed on principles involving the transmission of sound in water. By old methods a sounding in 20,000 feet, with piano wire and a spherical weight, required an hour with the ship stopped. An echo sounding can now be made in the same depth in eight seconds with the ship cruising at full speed.

The knowledge of the velocity of sound in sea water is used in determining the geographic positions of the soundings. Radio acoustic ranging accurately locates the survey ship when out of sight of land by measurement of the time intervals required for the sound impulse from a depth bomb, exploded near the ship, to travel horizontally to hydrophones, sensitive mechanical "ears," suspended from buoys planted at sea and located geographically by a scheme of marine triangulation.

The impulse from the bomb explosion near the ship (Figure 1) moves to a hydrophone in the ship's bottom and is there passed electrically to a time-measuring instrument, the chronograph, which records it on a tape. The later receipt of the same water-transmitted sound wave at the distant hydrophones of the various widely separated sono-radio buoys is flashed back instantly to the survey ship by the automatic radios on these buoys, and is recorded on the same tape. The time intervals, scaled from the tape to a hundredth of a second, and multiplied by the velocity of sound in water, gave the distances of the ship from the buoys. The intersection on the plotting sheet of these distance arcs from two or more of the buoys determines the ship's position.

THESE sound impulses travel comparatively long distances, occasionally well over a hundred miles. They reach greater distances in cold water than in warm. During the previous summer, surveying ships of the United States Coast and Geodetic Survey obtained bomb returns of 138 seconds — about 110 miles — in the cold waters of the Aleutian Islands.

The bombs are timed by the length of fuse to explode at a depth of about 100 feet. They are made

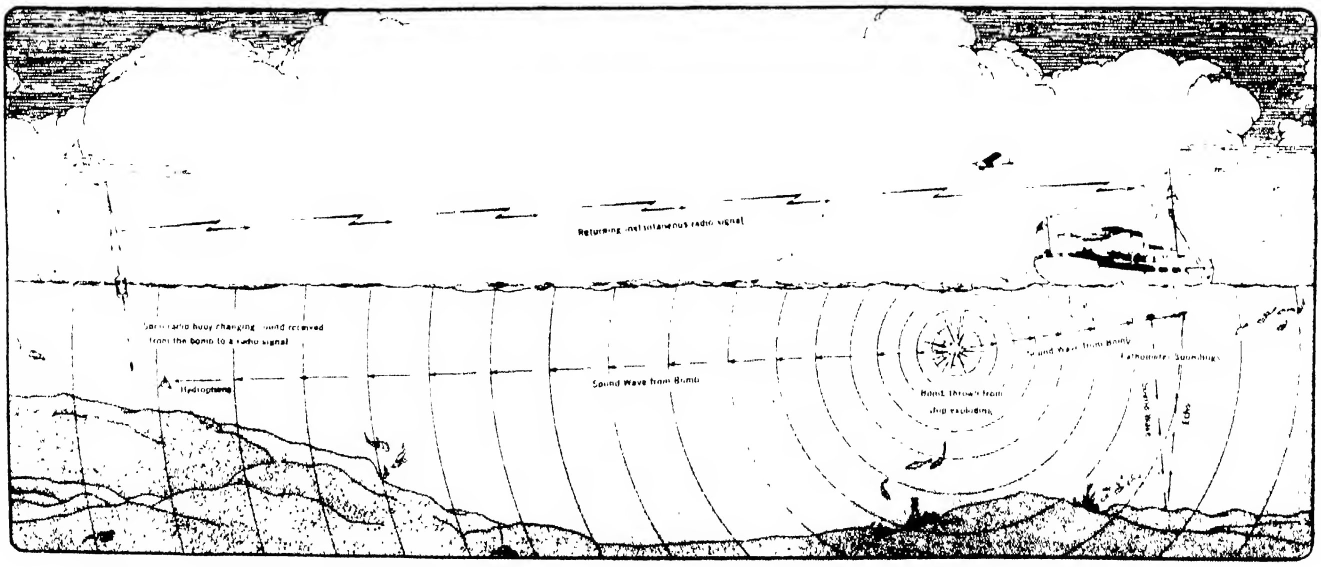


Figure 1: **To make a topographic map, the vertical elevations and horizontal positions of innumerable points must be determined. Drawing shows how, despite difficulties, this is accurately being done at sea**

on board as required and contain from four ounces to four pounds of T.N.T., depending upon the distances to be measured. Their construction is simple, requiring only a friction-top tin can, weighted with a small quantity of lead.

The sono-radio buoy (Figure 2), built aboard the survey ship, consists of a 50-gallon oil drum with a 20-foot superstructure for attaching the antenna of the automatic radio contained within the drum. One such buoy was recently anchored in 7800 feet of water, by a Coast and Geodetic Survey vessel operating in the Gulf of Mexico. Aircraft wire was used, with an anchor-detaching apparatus near its lower end to insure recovery of the wire. Anchors usually consist of discarded car couplings of little value.

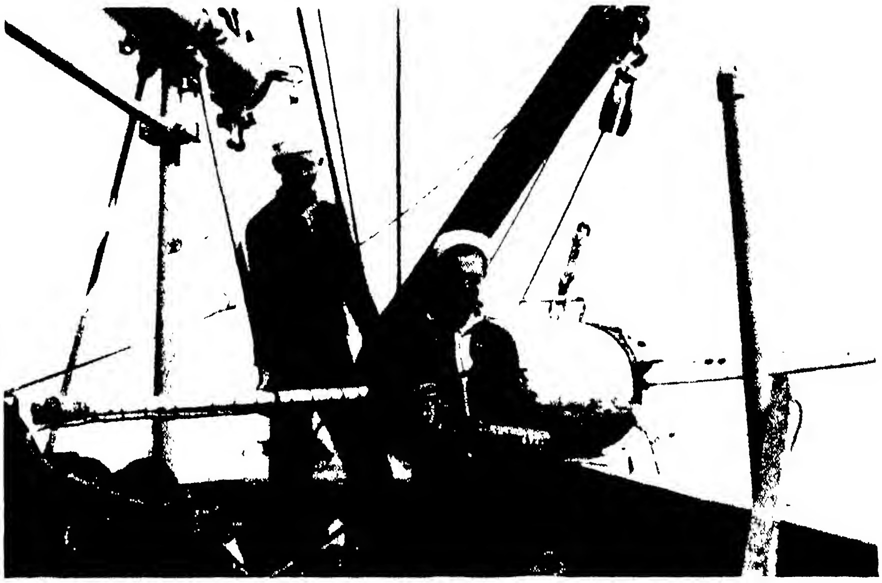


Figure 2: **An all-metal sono-radio buoy (compare with sketch in Figure 1) and its attached hydrophone, in the arm of the sailor on right**

Radio-acoustic triangulation at sea, not to be confused with the radio-acoustic ranging just described, is similar in principle to triangulation for control of land surveys, and consists of surveying a continuous scheme of triangles (Figure 3). On land, the apex of each triangle is marked by a metal disk set in a concrete monument; the lengths of the triangle sides are computed by trigonometry, using the angles of the triangles observed with a theodolite mounted on top of towers erected over the disks (Figure 4). First, however, a base line is measured as an initial distance, from which other distances in the scheme can be computed. Such a line is represented by the heavy line near the middle of the island in the sketch (Figure 3) of the triangulation recently established on Cagayan Sulu Island in the Sulu Sea. The sketch also indicates the method of expansion of a scheme from this base line to off-lying islands. By other computations the geographic positions of all the stations can be readily determined. These stations furnish control for both the land survey and the hydrographic survey of the nearby water area.

Figure 3: **Triangulation scheme from a measured base line (heavy line) on an island, expanded to the off-lying islands**

In establishing triangulation at sea, obviously a theodolite can not be used on the unstable deck of a ship, nor can stations be permanently marked. Resort must be made to the expedient of anchoring sono-radio buoys to mark the apex of the triangles and to taut-wire measurements and radio-acoustic ranging to determine the lengths of the triangles and to taut-wire lengths, the geographic positions of the buoys can be determined by computations similar (Figure 5) to those used in land triangulation. Radio-acoustic triangulation recently established for controlling a survey of a part of the Gulf of Maine is shown in this figure. The area surveyed, indicated on the sketch by stippling, is roughly 115 miles in length, 70 miles in width, and covers about 7200 square miles.

First a closed loop of "sea traverse" was measured from buoy *A* (located by sextant angles to shore objects) to buoy *B*, thence to buoy *C* and on to buoy *D*, which was also located by sextant angles from shore. Intermediate buoys, the adjacent ones intervisible from the

Figure 4: **Steel towers like this can be used for triangulation on land, but cannot be set at sea, hence, less direct means are used**

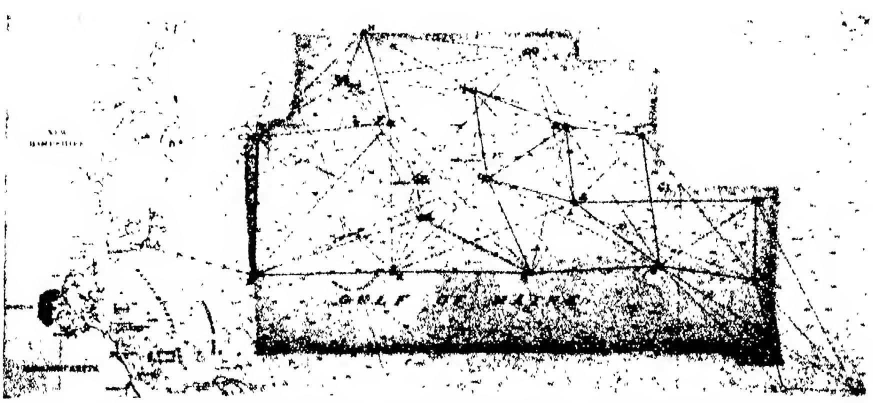


Figure 5: **Radio-acoustic (marine) triangulation for controlling a hydrographic survey of the Gulf of Maine. Explained in the text**

ship's bridge, were also planted along the line of traverse *CD*. Next, the traverse was measured by a "taut-wire" apparatus (Figure 6), developed by the British and adapted by the Coast and Geodetic Survey to buoy control. This apparatus is composed of a reel of piano wire (about 140 miles in length) which can be payed out under constant tension over a registering sheave as the surveying ship steams along. The end of the wire is anchored near the initial buoy, the ship steams along the line of intermediate buoys paying out the wire, and the distances between buoys are determined by readings on the sheave as each buoy is passed. No effort is made to recover the wire.

The true azimuth (horizontal angle) between adjacent buoys is obtained by a determination with sextants of the horizontal angle

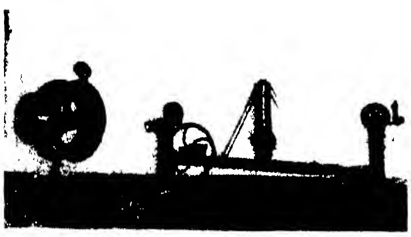


Figure 6: **Taut-wire apparatus: 42½-inch reel, recorder, sheaves**

between the Sun and the buoys when on range. With such data the geographic positions of buoys *A* and *B* (Figure 5) and the distance *BC* (heavy line), can be readily computed. In the survey made, the line *BC* served as a base for the radio-acoustic triangulation. Buoys *E* and *F* were then planted and the lengths of the lines *BE*, *BF*, *CE*, *CF*, and *EF* determined by radio-acoustic bombing or by taut-wire measurements. With the lengths of sides of all triangles known, quadrilateral *BCFE* was computed. This procedure was continued throughout the scheme as it progressed seaward. To increase the accuracy, more lines were bombed than the necessary minimum, as is shown in the figure. Wire-measured lines are indicated by continuous lines, bombed distances by broken lines.

As the summer advanced, the warming of the top layer of water impeded the progress of the sound waves and it became necessary to increase the number of buoys in the scheme so that the surveying ship could determine its position at any time from at least three buoys. When the survey gradually progressed seaward, the buoys were removed to new locations.

At the close of the survey season two ordinary navigation buoys were planted at positions *X* and *Y* (Figure 5) in the comparatively shoal water on the north edge of Georges Bank and connected with the triangulation scheme, to serve in the next season as the base for continuing the scheme, just as the line *BC* served to start it.

The Gulf of Maine project is indicative of the distances co-ordinated surveys may be carried offshore. In addition, radio-acoustic ranging methods permit the surveying ship to work through the night and during the densest fog with its position as accurately known to the hydrographer as on the clearest day.

• • •

OIL WELLS

Sciences Beat Hunches in Discovering New 1940 Fields

OIL-WELL drillers who took the advice of scientists in their search for new oil fields in 1940 were three to four times as successful as the drillers who located their exploratory wells by non-scientific doodle-bugs, dreams, or what-not.

One tenth of all the wells drilled by the petroleum industry in 1940 were out beyond the limits of present oil fields—wildcat wells drilled in an attempt to find new fields. One eighth of these wildcat exploratory wells, 366, were successful, opening up new oil and gas fields; the remaining 2672 were failures—dry holes.

Most of the wells drilled by the industry are within the supposed boundaries of proved fields, to develop those fields. But every year several thousand locations are picked where no oil has been found, and exploratory wells are drilled. That even one eighth of these are successful is a tribute to the scientific skill and daring of oil men. Many of these wildcat wells penetrate more than two miles, cost from $150,000 up, and find nothing but dust.

A number of well sites still are chosen because of guesses, witch-hazel rods, or divine inspiration. Some of them do find oil. Most new drilling locations, however, are picked after detailed scientific surveys, and their chance of success is three to four times as great as those located by non-scientific methods. Of the 1940 wildcats, 2051 were drilled on technical advice—geology, geophysics, or a combination of the two—and 320 of them were successful. Sundry non-technical reasons were the excuse for drilling other exploratory wells; only 35 found oil.

COSMIC RAYS

They Turn Out to be Protons And Produce Mesotrons

THE cosmic rays seem to be mostly of protons, the heavy parts of atoms, rather than electrons. New evidence in favor of this theory is contained in experiments reported by Dr. Arthur H. Compton.

Measurements made of the cosmic rays far above the surface of the earth, from airplanes and balloons, fit in with the idea that protons, with positive electrical charges, are the primary cosmic rays. When these strike the nuclei of atoms in the air, they produce mesotrons, which constitute an important part of the cosmic radiation observed on the earth's surface.—*Science Service*.

OUR *Point* OF VIEW

AIR CONDITIONING FOR HUMANS

As far as its use in connection with *wares and materials*—cotton, wool, tobacco, paper, and the like—is concerned the high value of air conditioning stands established, but what of its use in connection with *human beings* and their health, not for materials?

Here medicine has something to say; it says, mainly, that we still lack the final answers, and it says in effect "Not so fast—not so fast"; for a human being is not a quantity of merchandise. No doctor has uttered just these exact words but they are not far from thoughts recently expressed by the chairman of the American Medical Association's Committee to Study Air Conditioning, Carey P. McCord, M.D., of Detroit, who pointed out to the Third Annual Congress on Industrial Health that "engineering capacity is far ahead of medical guidance in connection with air conditioning." Dr. McCord's report—some 5000 words of it—is set forth in the *Journal of the American Medical Association.*

Judged by comments about air conditioned buildings, made by those whom one meets here and there, a great many persons have rather pointed private opinions about air conditioning, especially where cooling in summer is involved; the reader no doubt has his own. Let's see what American Medical Association Committeeman Dr. McCord has to say about it.

When man's ancestor some hundreds of thousands of years ago began to substitute for his coat of hair a layer of subcutaneous fat, he could scarcely have foreseen air conditioning, for he thus became a naked animal organism highly individualistic to his atmospheric environment. He adopted scores of delicate physiological mechanisms not needed by the other animals—a sensitive system of temperature balance and control—to compensate for his nakedness. These established controls now simply refuse to get in line with the present effort by air conditioning to divert the biologic course of a million years, nor can all man's boasted scientific skills make them get in line.

The incidence of respiratory diseases—colds, pneumonia, and the like—is the central strand of Dr. McCord's discussion and he points out how naively people took for granted, some years ago, that air conditioning would lessen these diseases among assembled groups of people, as in offices and factories. By air conditioning is meant not merely ventilation but control of air quality by heating or cooling, or by drying or moistening, or by purifying.

If we try to isolate the effects, in causing respiratory diseases, of a given air conditioning feature—dust, for example—we cannot with assurance do this because the evidence seems uncertain and opinions differ. Do so-called harmless industrial dusts play any considerable part in causing ordinary respiratory diseases? Dr. McCord has himself observed, as has the present writer, that when troops live in tents, hence without close congestion, these diseases nevertheless increase enormously after dust storms; though they do not so increase with troops similarly exposed to wind but not to dust. Hence dust alone must be a factor in these diseases and its trapping by installations may be praiseworthy, though mere filtration is not air conditioning.

"Some atmospheres provided in the name of comfort air conditioning are so far removed from optimal air conditioning," the report significantly notes, "as to *favor* both discomfort and the occurrence of respiratory and probably other diseases." Have any of our readers ever entertained similar thoughts, possibly with less polite trimmings, as they slowly congealed?

Such, however, are bad types of air conditioning; how about the best types—do they too cause less respiratory disease or more of it? The doctor says that here enormous benefits have been claimed on poorly supported evidence, but newer evidence of a statistical nature now gives answer. In three places, large numbers of workers in modern air conditioned buildings were given prolonged tests against similar numbers in old buildings not air conditioned. The result is a surprise: no lowered incidence of colds or other respiratory diseases was found.

Of course, if records are made where people live continuously in air conditioned buildings—for example, patients in hospitals—respiratory disease is usually diminished. But how can most of us so live—unless we were willing to live as does Gargantua, the Ringling Circus gorilla who dwells in continuous air conditioning, but in a cage.

"Air conditioning shock" is the discomfort on emerging from a cooled place into warmer air, and the results often are not good if the temperature differential is as much as 20 degrees, Fahrenheit, on a hot day—though it must be admitted that we do not think it extraordinary when emerging from an 80 degree room into a zero degree winter's day. Factors possibly not yet understood or even yet discovered may someday explain this odd discrepancy. Generally, it is admitted, an air conditioned room is a comfort on a hot, muggy day, but who has not actually shivered or even taken cold in an overcooled motion picture house or other place? In place of the 15-degree differential now so widely endorsed many would prefer and be satisfied with only a five-degree differential; the hotter the day the lower the differential.

Thus Dr. McCord concludes, as has been said, that engineering capacity is still far ahead of medical guidance in connection with air conditioning, and he even fears that doctors never will be able to put in the hands of engineers any bill of air conditioning particulars uniformly suited to all person's bodies and tastes. And, anyway, he says, too much is expected of air conditioning, to begin with. That, largely, is what probably is wrong; it isn't the air conditioning but *us,* and the worst of it is that next to nothing can be done about us. We—our physiological mechanisms—are fixed, or practically so. Won't evolution alter and adapt us to a future where everything will be air conditioned? She probably would—in about 100,000 years.—*A. G. I.*

Pilots, Pilots, More Pilots

Encouragement of Glider Clubs Would Provide Ample Raw Material for Military Needs

COMMANDER E. F. McDONALD, Jr.

If there is one phase of our present national-defense effort which has supreme importance, it is the training of military pilots. Despite the doleful carping of critics who do not understand the long preparatory work necessary for mass production, our industrial facilities for the manufacture of war materials are expanding rapidly. Man power for the navy is being trained as rapidly as ships are, or will be, built, and our ground soldiers will be ready by the time we have weapons to give them. But in the air the the situation is different.

We need pilots, pilots, and more pilots; but where the mechanically trained youth of America give us an abundance of potential mechanized fighting men, we have no pool of flying youths on which to draw for pilots. It takes a long time to train a competent military flyer; a youngster who has never flown knows little more about actual flying than the Russian peasant who kicks a stalled tractor knows about mechanics. College youths now taking the CAA courses spend about nine months getting the rough equivalent of the primary basic course given at our flying "West Points." These courses are available to far too few; we must have flight training for millions of youngsters, and not restrict it to the select minority who reach college. I know from my experience in the industry that everything we have in radio today came from enthusiastic amateurs, and that a large percentage of them did not have the benefit of formal education. Had radio been restricted to a limited circle, we would have few of the technical developments which have given America the finest radio system on earth.

There is a practical, economical, and effective solution to this problem. We can open aviation to every interested youngster by giving him the opportunity to learn to soar. When he has learned to operate his sailplane, to use the moving air currents to maintain flight, to meet the ever-recurring small emergencies that come on every glider flight, he will know so much about flying that he can be turned into a power-plane pilot in a fraction of the time and at a fraction of the cost for training a raw beginner. Moreover, he will be a better pilot than the lad who starts directly on power, for he will learn things about the air that a power pilot may never learn until it is too late. The difference is much the same as that between a man who learns to sail a boat and one who learns motor-boating first; the sailor can go into power-boating with little trouble, but the motor-boat operator must learn all over again when he takes up sailing. He does not know the importance of wind and current until the day his power fails and he drifts upon the rocks.

● **Other aspects of soaring flight than those of pilot training, dealt with in the accompanying article, are receiving serious attention by military authorities abroad. Thus, *The Aeroplane* (London), in a recent issue, discussed troop-carrying glider trains in which the gliders to be towed by a powered plane are connected by cables that are wound on drums prior to take-off, permitting operation from relatively small fields. Seriously considered, also, are gliders for transporting supplies to military forces in the field, and even winged tanks for invasion purposes. These latter consist essentially of gliders in which the fuselage is replaced by the tank itself. Says *The Aeroplane:* "In the design of a glider . . . to carry a tank . . . both supporting and controlling surfaces would be attached and braced direct to the tank. . ."—*The Editor.*** ●

American youth is very air-minded, but the great majority of our boys begin to lose interest after they have outgrown the model-building stage. They have neither the money nor the opportunity to learn power flight, and in many cases their parents object on grounds of safety.

With gliding it is different. There is hardly a hamlet or city in the land where gliding instruction cannot be given, hardly a community that cannot support a gliding club of 15 or more persons. Membership need not be restricted to potential warbirds; men and women of all ages can learn to soar and participate in one of the safest and grandest sports that human ingenuity has ever devised.

Even with the relatively high cost for gliders, the expense of club membership is low. One training ship is sufficient for instructing 15 or 20 persons, more if the students are under 18 years of age. Its cost, with trailer for transporting it, will range from $800 to $1000. One club member can qualify as an instructor by taking a course at any of several glider schools; the cost will be about $225. In addition, the club will need an old car for towing; another $100. A winch for high-altitude towing will cost anything up to $250, depending on whether it is purchased complete or built up from an old automobile. Operating expense then comes down to fuel, tow ropes, occasional patching of wing tip fabric, and so on — perhaps $75 for a year of operation. It works out that a club of 20 boys can operate for its first year with an initial fee of $20 per boy and dues of $5 per month. Dues can be slashed after the first year, or can be maintained with the intention of purchasing additional ships.

Glider costs will come down as mass-production methods are introduced. Moreover, we can borrow from German experience, and let our youngsters build their own. In the early 1920's German youth was given an opportunity to buy plans and specifications at cost. From these they built gliders costing less than $100, had them inspected by the government before covering the framework with fabric, and were ready to start gliding.

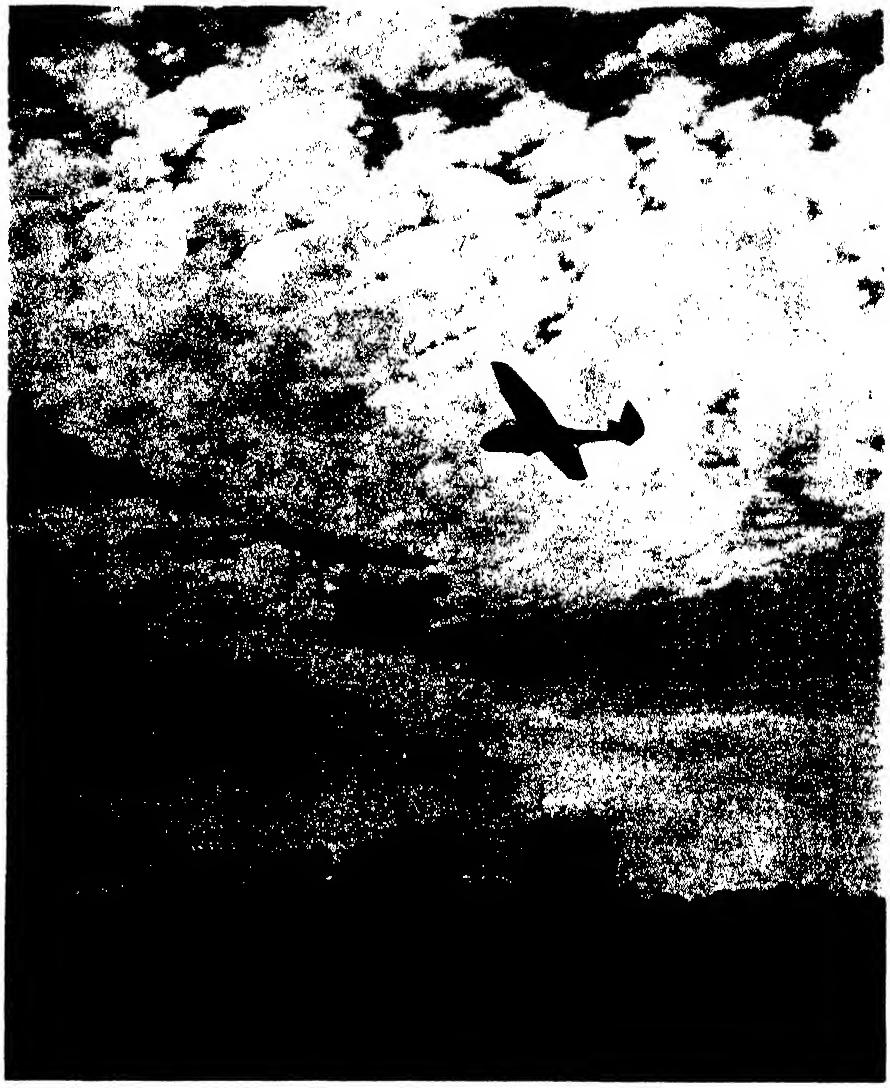
As their technique improved, they began construction of the higher performance sailplanes which were then being developed. Their tremendous progress in the art is shown by the way records toppled. Although a flight of over 1300 feet was made as early as 1891, it was not until 1920 that anybody

glided more than a mile. Then the records began to fall: 8.6 miles in 1922, 15 miles in 1925, 93 miles in 1929, and 143 miles in 1933. The world's record today is 465 miles.

When Hitler came to power in 1933 he found a ready-made group of skilled flyers who had never touched an airplane throttle. From these he rapidly developed his immense air force. There has been much propaganda from both sides about the relative merits of German and British pilots. Impartial observers seem to agree that their ability is about the same. However, it is certain that Germany had vast numerical superiority, and that this was true even after the war had been in progress for a year. Britain got started on a program of pilot-training and air-force expansion shortly after Munich, but British pilots had to start their training from scratch.

With our present knowledge of gliding and soaring we can develop an enormous reservoir of air-minded youngsters in a few months — something that is physically impossible under present training systems. From the cream of this reservoir we will be able to select thousands of apt pupils for military training, and, because of their basic flight knowledge, will be able to save weeks and months in finishing their training. It is impossible to estimate the financial saving with any degree of accuracy, but it will be tremendous. Gliders do not require expensive airports and ground crews; local clubs will carry the boys through to proficiency for a fraction of what it would take to make equivalent progress in power. Moreover, by learning their ABC's without cluttering up our other training facilities, these boys will leave the power instructors and their equipment free for more advanced training.

Learning to glide is simple and safe. The glider is nothing but a light, engineless airplane. Its flying controls are identical with those of a light powered ship. The student is strapped into place, shown what to do, and towed slowly across the field until he learns the use of rudder and stick to keep his ship in line with the tow car and balanced on its single landing wheel. Then the tow speed is increased until flying speed is reached. The fledgling hedge-hops for a few tows, and is then permitted to go higher, release the tow rope, and glide to earth. Even if he gets excited and comes down on a wing tip, little harm will be done, for he is moving only 20 or 30 miles an hour.



A Frankfort sailplane seeks a thermal

After a few hours instruction the beginner is ready for longer glides and is towed 50, 60, or more feet into the air before cutting loose. His ship has a sinking speed that is an inherent characteristic of its design — usually about three feet per second in a trainer. He watches his airspeed indicator to make sure that he maintains the proper gliding angle. If he slows down, the stick goes forward to steepen the glide; if it picks up too much speed, the stick is eased back.

With the straight glide mastered, the embryo pilot is ready for turns, starting with simple right angles and progressing to full circle, figure-eights, and so on. He will make the same mistakes a beginner in power flying will make; his bank may be so flat that he skids, or so steep that he side-slips. He maneuvers in exactly the same way that he would with power, but his controls are a little softer because of the low speed, and he has to master the feel of flight and use of instruments much more completely than the power pilot. He must also plan his flight more carefully, because he has no engine to help him if he underestimates his glide, or to pull him out of trouble if he overshoots. If he misses his mark and lands far from the field he has selected, he may have a rather unwelcome chore in disassembling the ship and getting it back to the landing field. If he lands in trees he may damage his ship, but usually not seriously, and in any case, due to low landing speed and a light ship, his chances of personal injury are very slight.

When he graduates to a sailplane he is ready for soaring. This ship is simply a lighter, higher performance glider than his trainer. Its sinking speed may be little more than two feet per second, its cruis-

Student, in training glider, receives last-minute instructions

ing speed from 35 to 60 miles per hour. When launched from a high tow with a sailplane, the student begins feeling for ascending columns of air, going by sense of touch, observation of weather conditions and topography, and by the reading of his variometer, which is calibrated in feet per second rather than in feet per minute. If the wind is blowing against a bluff or ridge, he will fly in that direction, and soar along the upward current like a gull or eagle. His sinking speed, relative to the air, remains constant, but the air through which he flies is rising. He may soar on thermals — ascending bubbles of heated air — which he spots by the clouds above them, the movements of soaring birds, or by his knowledge of topography. When he finds one he will spiral within it while the vertical air current carries him up.

All of this is precision flying, with careful attention to topography, drift, and position. The pilot forms flying habits of great value; for example, he knows that there are descending currents on the lee sides of hills, and will never miscalculate the effect of a down draft, an error which has cost lives when made in power-planes. He knows the turbulence inside thunderheads, and knows the smooth and turbulent portions of "fronts." He can utilize these conditions to his advantage when flying with power, and will automatically avoid danger zones which have caused accidents for experienced power pilots who had no training in motorless flight.

Some of our best commercial pilots today are soaring experts and enthusiasts. Captain Shelly Charles, of Eastern Airlines, uses his mastery of the art to bring greater safety, passenger comfort, and efficiency while flying his heavy Douglas transport. Lewin Barringer once used his knowledge of ridge currents to avoid a forced landing miles from camp while piloting for the Joint Iranian Expedition of 1935-36. Estol Coll took a light plane over Mt. McKinley after another pilot, schooled only in conventional flying, was unable to exceed an altitude of 17,000 feet with a more powerful ship. Peter Riedel's knowledge of up-and-down air movements enabled him to make crossings of the Andes at phenomenal speeds.

Germany is the only outstanding example today of mass pilot training by gliders. In our country, however, the idea is beginning to catch on. The Lewis School of Aeronautics at Lockport, Illinois, is including glider instruction in its course. The Wilbur Wright Junior College of Chicago has an aviation club of 105 members, 20 of whom are girls. Sailplane lessons are part of their training. A group of graduates from the CAA primary course in power flight were given sailplane lessons last summer. One student, cocky over his wings and contemptuous of gliding, came close to a serious accident because he forgot about not having power to pull him out of a stall.

There will unquestionably be a vast increase in soaring activity during 1941, but there is much that should be done to speed it up. Schools, service clubs, youth organizations, churches, and civic organizations should encourage formation of clubs in their communities. The government should take it up seriously, subsidizing gliding schools and encouraging other schools to get programs started. It should go even further

Operator of tow winch signaling for a start

and include glider construction and training in the NYA program.

Commercial production is still lagging, although rising public interest has stimulated manufacturers, and one company, the Frankfort Sailplane Company, of Joliet, Illinois, has just received the first Class I certificate issued for sailplanes by the CAA. As yet no manufacturer has been able to use mass production methods as a means of lowering costs, but that development is rapidly approaching. As the demand for sailplanes and gliders increases, there is no doubt that means will be found to reduce production costs and hence the final price per glider or sailplane unit to the user.

If we bring down the cost of soaring to where more youngsters may learn to fly, and put American youth into gliders, we need have no fear for our future air-force personnel.

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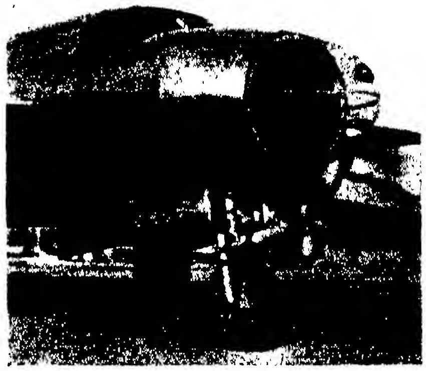
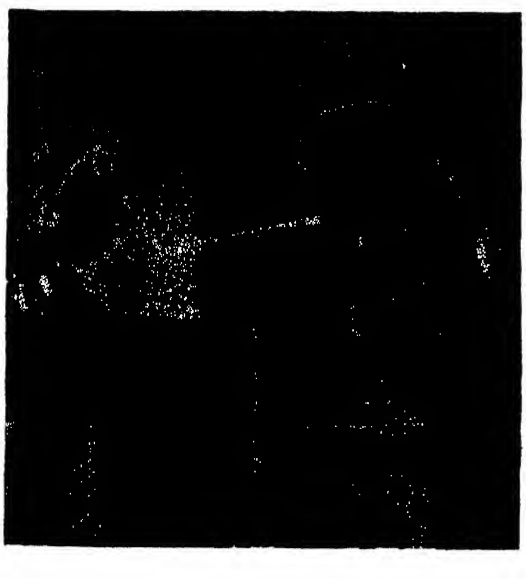
'Green-Houses' For Bombers

Plastic Enclosures Reduce Plane Weight, Hence Increase Speed or Bomb Capacity

PROVIDING perfect vision and protection for the combat crew of a modern warplane is no small problem. Perfect vision is vital, for blind spots in the crews' enclosures would permit enemy planes to sneak up unobserved; flaws would throw off the gunners' aim. Protection for the crew is just as important; a gunner or bombardier who is cold or wind-battered is inclined to be inaccurate or careless. Other problems include the need for more perfectly streamlined contours to reduce "drag." These requirements are met by Plexiglas, a crystal-clear plastic, shatterproof and less than half the weight of glass, now in general use on American-built bombers and fighters being delivered to Britain and to our own armed forces. Accompanying photos show steps in fabricating a bomber's nose from this material.



The Martin bomber, at right above, is equipped with a "green-house" of plastic sheet, shown at left in the first stages of being molded to shape while heated to plasticity



Left: The formed plastic sheet is cut with a band-saw to exact size. The material is shatterproof but is not actually bullet-proof

Right: Trimming the edges of bombardier's door and gun mount hole. The hardware will be bolted in place directly on the plastic

Above, right: Polishing and buffing are the final step in the production of the bomber noses

More Power to the South

Development of South Carolina Engineering Project Will Provide for New Industries

HAMILTON M. WRIGHT

THE Santee-Cooper power and navigation project, located less than 50 miles north of Charleston, South Carolina, and with an estimated completion cost of $45,795,000, ranks with the most important public works that have been recently constructed in the United States. Unlike many similar enterprises whose development has attracted national interest, however, the water held in the two huge reservoirs, covering an area of 250 square miles, will not be used for irrigation; its primary purpose is to provide power for needed industries, and, secondarily, to make available a commercial waterway 164 miles in length for craft of draught not exceeding ten feet, between Charleston and Columbia.

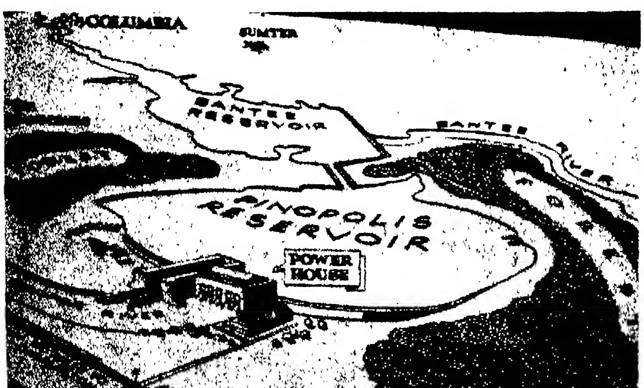
Incidentally, the developed area is expected to create a huge pleasure vacation ground in which large fresh water lakes teeming with game fish, adjoining a region in the historic South famed for its game birds and deer, will provide a new national attraction.

The Santee-Cooper project will furnish low-cost electrical power to a nearby region which for many decades has been undeveloped and which, even within the past generation, has lost considerably in population and wealth, but which now has become a rapidly progressing section of the South. The coastal country where the project lies is rich in pine and hardwood timber and in agricultural products, and contains extensive mineral deposits, all of which are suitable as the raw materials for new manufacturing industries when cheap power or fuel are available. The lack of cheap power is one of the alleged reasons for the failure of the rich coastal area of South Carolina to advance proportionally with the interior Piedmont section of the state.

The Santee is the largest river, within the limits of the United States, which flows into the Atlantic Ocean. It is almost the sole source of the water which will be impounded to provide electrical power, since the Cooper River, from which the project partly takes its name, is, in comparison, an almost negligible contributor. The mean annual flow of the Santee at Ferguson, South Carolina, for the past 32 years, has been 18,349 cubic feet per second. With its principal tributaries, the Wateree, Broad, and Saluda Rivers and their affluents, it has a drainage basin upstream from the Santee Dam of 15,000 square miles. Reservoirs which feed power plants are already installed along these important tributaries. They include the Parr Shoals Plant on the Broad River, Lake Murray on the Saluda River, and Camden Reservoir on the Wateree River. These reservoirs, of course, directly affect the flow of water in the Santee River at the Santee Dam. At times they may act as a balance wheel in equalizing the flow, but they may also decrease it. The minimum discharge of the Santee River at Ferguson during the 32 years of record, was 2570 cubic feet per second, this low figure being due to the regulation of the upstream reservoirs.

UPON completion of the Santee-Cooper project, the first dam to be seen by the pilot of a craft proceeding down the Santee Reservoir from Columbia, South Carolina, will be the great Santee Dam at Wilson's Landing on the Santee River, which is now almost finished. He will not reach the dam, however, but when within a mile or so of it will turn to the right, passing through a diversion canal almost eight miles in length, 200 feet in width, and 10 feet maximum depth, to the vast Pinopolis Reservoir, created by the damming of a huge forested swamp whose waters flow into the Cooper River. He will pass from the reservoir to the river by a navigation lock with a lock chamber 180 feet long and with a 75-foot lift, one of the highest single-lift locks in the United States. Upon its exit from the lock, the barge will pass by a canal to the Cooper River and thence to Charleston.

Next to the lock is the power station, the heart of the Santee-Cooper Project, which will have a total water head of 75 feet discharging through the turbines and



Left: **Map of Santee-Cooper project, showing rail, highway, and steamship facilities which tap forest, agricultural, and mineral resources.** *Right:* **Air view of Pinopolis locks and the power house**

flowing into a tail canal four and one-half miles in length, connecting with the Cooper River.

The normal elevation of Santee River above sea level at Santee Dam is approximately 40 feet, and it is 80 miles down river to the sea. When the reservoir upstream from the dam is flooded next fall, the water will be raised by an earthen dyke or dam, the crest of which will be 88 feet above sea level, to a height of 75 feet above the sea. The dyke is approximately eight miles long, including a 3400-foot concrete spillway protected by extensive use of deep-driven steel pile sheathing and steel and concrete foundations to prevent water from undermining or working around the spillway. Starting at elevation 88 feet the dyke will be faced with concrete slabs down to elevation 55 feet, or natural ground level.

THE slope of the Santee Valley is from one half to nine tenths of a foot per mile and in a lake as big as Santee Reservoir, covering as it will 155 square miles and extending up the Santee Valley for many miles, a considerable wash can be expected when the wind is in the right direction. The concrete slabs will serve as a protection against these waves and their action on the soil.

Upstream from Santee Dam, the great swamp of the Santee was filled with dense forests of valuable hardwoods, gums, cypress. Contracts were let by the South Carolina Public Service Authority, in charge of the project, to some 30 lumber companies to clear the forests from the reservoir site. Logging railroads, some of them 20 miles long, were run deep into Santee Swamp, and trainloads of huge logs from an area of virgin timber began to issue from the swamp in great volume, until by the first of the year only 40,000,000 feet of timber remained to be removed.

Construction view of longest earthen dam—the Santee—in the United States

After the forests were logged, camps of workers, 6000 to 8000 in number, cleared the basins of the remaining timber. They are still, at this writing, engaged in this work.

Pinopolis Dam, which will hold back the water of Pinopolis Reservoir — 95 square miles in area — is two miles in length and is of earth construction, except for the lock and power station. The latter is approximately 380 feet in length and is bordered on one side by immense concrete stanchions, six stories high, which connect with the dam, and on the other by the navigation lock. There are approximately 26 miles of earth dykes around the Pinopolis Reservoir; these, like the dyke at Santee Lake, have a crest elevation of 88 feet and will be similarly surfaced with concrete slabs in the exposed sections.

Equipment to be installed in the power house will consist of four 40,000 horsepower turbines directly connected to four 34,000 kilo-volt-ampere generators: and one 13,300 horsepower turbine directly connected to one 11,350 kilo-volt-ampere generator. Provision is made for an additional 40,000 horsepower generating unit in the future.

Thus the Santee-Cooper power station will have an initial installed capacity of 173,300 horsepower, and an ultimate installed capacity of 213,300 horsepower. Installation of the huge turbines, from the General Electric Company, has already begun.

Retaining wall, turbine construction, discharge end of draft tubes

THE Santee-Cooper power station will provide cheap power in an area which had a population in 1940 of 743,977 and which is rich in natural products but lacks manufactures. As is almost always the case, the area operates at an economic disadvantage when it exchanges its agricultural products for manufactures produced elsewhere and lacks the money distributed by manufacturing industries. For example, the coastal area of South Carolina produced 307,125 five-hundred pound bales of cotton in 1940 and has not a single cotton mill in operation. This cotton ranks among the best, producing 95.5 percent of its crops with lint 15/16 of an inch or longer, in comparison with an average of 73.4 percent for the whole United States.

South of an imaginary line extending from Augusta, Georgia, through Bamberg, Orangeburg, Sumter, Florence, and Dillon, South Carolina, and on to Lumberton, North Carolina, there are no cotton mills in operation. On the line in the counties traversed by it are only seven mills. A high official of the Cotton-Textile Institute said recently that he knew of no reason why this coastal area should not engage in cotton manu-

facture. A spinning mill operated by 1000 horsepower from the Santee-Cooper Project, producing 20 to 30 thread on the average, would consume 5000 to 6000 bales of cotton per annum.

But cotton manufacture is only one of the industries that may be stimulated by the Santee-Cooper Project. Experts have listed many new industries now possible to the area, basing their opinions on the power out-put of the project. The annual generating capacity during a year of average stream flow will be 700,000,000 kilowatt-hours, of which 450,000,000 kilowatt-hours will be prime and 250,000,000 kilowatt-hours secondary power. It has been estimated that cotton mills and tobacco factories would consume 30,000,000 kilowatt-hours of this electricity annually, and two inland machine kraft mills 160,000,000 annually. There are vast pulp resources in the coastal area of South Carolina, and, despite the great increase in kraft paper production in the South, the demand for paper boxes and containers has so swiftly risen that importations of pulp, pulpwood products, and similar raw materials for the paper industry continue at a rate upwards of $150,000,000 annually. The manufacture of cement, fertilizers, and of many other products of local consumption is also made possible by the new plant, which is hailed as a major step in the big comback now being staged by the southeastern states.

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SAMPLING

New Apparatus for Taking Sea Bed Samples

Two Swedish scientists, Prof. Hans Pettersson and Dr. Börje Kullenberg, both of the Oceanographic Institute at Gothenburg, expect to be able to explore the history of the oceans over thousands of years with the aid of a new apparatus which they have jointly constructed. With this device, which they have named the "vacuum lead," they aim to secure cross-section samples of the sediment layers on the sea bed of a greater length than has ever been possible before.

For a long time, the only method of obtaining such samples was with a so-called "push lead," a heavily weighted pipe which can be forced a couple of feet or more into the bottom of the ocean. It has seldom been possible to secure samples of more than a few inches in length with this device, however. An American scientist, Piggott, has developed a method of shooting such tubes into the sediment by means of an explosive charge, and in this way it has been possible to force down the instrument about ten feet into the bottom, but the method is both expensive and dangerous.

The two Swedish scientists let the water pressure itself force the tube into the sediment. Their apparatus consists of a tube 18 feet long, topped by a hollow ball of cast iron. When it is let down, the whole tube is filled with water, while the ball has been pumped empty of air. By means of a device in the lower end of the instrument, a valve from the pipe to the ball is opened at the moment the pipe touches bottom. The water then rushes into the ball, or "capacity," the pipe becomes empty of water, and is pushed into the sea bed by the enormous pressure of the surrounding water.

With their vacuum lead the two Swedish scientists have recently drawn up a plug of sediment layers about 14 feet long from the bottom of the Gullmar Fjord, on Sweden's west coast, which has enabled them to study the geo-chronological history of this inlet, layer by layer, for at least 4000 years back.

In such coastal waters deposits grow rapidly—about three feet per thousand years—but in the deeper parts of the ocean the deposits increase at a rate of only some three feet in 60,000 years, and in the deepest areas at perhaps only one tenth of this rate.

Sediment samples from the ocean depths provide material for studying the history of the earth in general, in a manner not possible with material obtained elsewhere.

MINE LOCOMOTIVES

Electric Power for Hauling Copper

More than 25,000 tons of ore, containing 500,000 pounds of copper, will be hauled each day from an Arizona mine by nine powerful electric locomotives built by Westinghouse. This amount of ore would load 500 fifty-ton-capacity freight cars—enough to form a train more than four miles long. The amount removed in a year would nearly equal the volume of concrete in Boulder Dam.

The new locomotives will bring the latest mass production methods to a region that has been mined for more than 60 years. During that time, the richest ores have been removed by underground mining operations. Now the locomotives will move large masses of copper-bearing rock in an open pit mine to recover the metal from the lower grade ores.

Each locomotive weighs 125 tons. Its four 380-horsepower electric motors give it a maximum pulling force of 31 tons. The locomotives are equipped to operate from a 750-volt overhead trolley wire on the main line between the mine and the ore crusher. At the loading benches, where track is moved frequently as the wall of the pit is dug away, each locomotive will receive power from its 13-ton storage battery.

One of the new electric locomotives designed for use in copper mining

Television Today

Commercial Operation, Large-Screen Projection, and Color Are Recent Developments

A. P. PECK

AT THE time of writing it is pretty definite that television transmission will be permitted to start on a full commercial operating basis on July 1. This will mean that television companies will be in a position to develop regular program services, paid for, at least in part, by advertising, and that public interest in this method of communication will start on the up-grade. As pointed out on page 13 of this issue, however, the future course of television will largely be determined, for some time to come, by the availability of materials and trained technicians, as dictated by the needs of national defense. In any event, there are certain aspects of the present television situation that hold immediate interest.

Large-screen television pictures, suitable for theatrical exhibition, constitute the most dramatic development of recent days. Projected from a device resembling a steel barrel, located at the edge of a theater balcony, these pictures fill a screen 15 by 20 feet. At a recent RCA and NBC demonstration in a New York theater, a complete program was presented utilizing equipment specially installed for the purpose. The program consisted of a playlet put on by "live" actors, a news broadcast, a newsreel picked up from film, and a ring-side pickup of a championship boxing match. All of these features were projected onto the large screen; spectators stated that the quality of reproduction was good, that the views of the fight were better than could be had from a ring-side seat.

All the transmission for this program was accomplished over specially balanced telephone wires, establishing a miniature network of the type which, television engineers state, may some day make theater television available all over the United States. The cost of equipping a theater for television projection, it is estimated, is between $25,000 and $30,000 under present conditions; increased demand for equipment and the consequent mass production would undoubtedly reduce these costs considerably.

Here is how the fight was televised and reproduced. Television cameras picked up the scene at the ringside, while long-range parabolic microphones caught the sound. The resulting picture and sound impulses were transmitted by wire to the theater; there they were unmixed, the light or picture impulses being directed to the projector and the sound impulses to a group of loudspeakers by means of two control consoles in the balcony. (See illustrations on this page and on page 4, this issue, for placement of equipment.)

THE sound system consisted of 16 loudspeakers set up in different positions throughout the auditorium. The arrangement of the speakers was such that the man at the control console could give direction to the sound. For example, if the operator saw from the screen that the sound was coming from the right, he would bring the loudspeakers on the right into play, and so on. The audience was thus given an illusion of three-dimensional sound.

The projector used in this demonstration is 34 inches in diameter and 34 inches long. Inside it is the kinescope, a large television receiving tube built to handle 60,000 to 70,000 volts, supplied by a high-voltage transformer. At the back of the barrel-shaped projector is a concave mirror 30 inches across. This reflector takes the televised images as they materialize on the face of the tube and casts them through a rectifying and magnifying lens to the screen, 60 feet away. When they reach the screen, the images are 15 by 20 feet.

While large-screen television reception cannot be termed "new" in every sense of the word, it is apparent that the system just briefly described holds the greatest promise of success of any of the other systems that have been experimented with and demonstrated in the past.

When the realm of television pictures in natural colors is considered, another new-old subject is found. Many workers in the television field have studied this phase, but the systems employed were usually impractical for one reason or another, complication of equipment being the general stumbling block. For some time, however, Dr. Peter C. Goldmark, Chief Television Engineer of the Columbia Broadcasting System, has been experimenting with a practical method of rendering television images in full color, using simple equipment and employing the same channel width as black-and-white transmission.

This color system is based on the

How a boxing match was televised for theatrical exhibition

familiar primary colors—red, blue, and green. Rotating filters of these colors are placed over the television image tubes at both the transmitter and receiver, the speed of rotation and the relative positions of the color segments being carefully synchronized. Thus the eye of the spectator receives successive images in the primary colors; retention of vision blends these together, giving to the brain an impression of an image seen in full color.

From all this it appears that television is at least beginning to don its swaddling clothes; as it learns to toddle and then to walk (from the public service and not from the laboratory viewpoint alone), a constant flow of improvements may be expected.

QUIET OFFICES

APPLICATION of noise-insulating mountings to a wide variety of office machines has been found to go a long way toward eliminating the distracting noises in offices which result in so much loss of energy to employees and hence increased costs to employers. These devices, of rubber and metal, called Vibro-Insulators by the manufacturer, the B. F. Goodrich Company, insulate not only noise but also vibration.

The company reports that the mountings have been successfully applied to key operated punches, alphabetical duplicating and printing punches, gang punches, reproducers, interpreters, automatic checking machines, multiplying punches, and all numeric and alphabetic printers and billers, and so on.

STUTTERERS

Was a Dictum of a Dozen Years Ago Wrong?

DISPUTING the old theory that teaching left-handed children to use their right hands, particularly for writing, is likely to cause them to stutter, Professor Harry J. Heltman, chairman of the School of Speech and Dramatic Arts at Syracuse University, recently declared that in a survey in which about 1600 students entering Syracuse were tested, out of 77 students who had had their handedness changed, only one of them stuttered.

The cerebral dominance theory is based on the findings of early surgeons that one side of the brain

is dominant. If a child is right-handed, it is said that the left side of his brain is dominant; while if he is left-handed, the right side of his brain takes the lead. Thus it has been suggested that teaching a left-handed child to write with his right hand is to force the weaker side of the brain to take the initiative and thereby disturb the whole nervous system and cause stuttering.

Professor Heltman summed up the survey with the contention that it is not so dangerous, from the speech aspect, to change a child's handedness, as has been supposed.

PLUG

All-Rubber Multiple Plug Has Novel Features

An unbreakable all-rubber multiple-outlet plug that is capable of withstanding extremely heavy pressure also features spring friction blades which provide permanently tight connections.

The plug, as shown in one of our illustrations, is molded of relatively

Metal parts are locked in place

soft rubber in a single unit, after which the metal parts are inserted and anchored by a patented process that locks them into place. The all-rubber construction makes these plugs suitable for use in any situation where multiple-outlet plugs are necessary and at the same time makes it possible to produce them in smaller sizes than ordinary types. The plug, produced by the United States Rubber Company, is scratch-proof and virtually unbreakable in ordinary use.

DUPLICATING

Stencils Give Visibility, Clean Reproduction

In a new type of duplicating stencil for office use, the visibility of stenciling is the same as that found in typing—namely, light on a dark background instead of dark

on a dark background. Thus eye strain on the part of the typist is eliminated and errors are reduced; furthermore, the typewriter type does not fill up as with conventional stencils.

The secret of this new stencil is a tissue sheet placed over the stencil sheet, plus a double thickness backing sheet. The tissue sheet remains in place until the stencil is completely cut so that layouts or tracings can be made in pencil on the tissue to act as a guide to the typist.

After a stencil is cut, the backing sheet next to the stencil can be removed and used as a proof sheet.

TRIGGER CONTROL

Fire Extinguisher is Rapid in Action

A HAND-OPERATED fire extinguisher which has a capacity of four pounds of carbon dioxide and is equipped with a trigger control valve has recently been developed by Walter Kidde and Company, Inc. The trigger-control valve is an outgrowth of a similar system formerly used on a smaller extinguisher.

Insures minimum wastage

In use, this extinguisher is discharged by simply pulling the trigger. This permits the extinguisher to go into action faster and insures minimum wastage of the carbon dioxide gas while the operator is maneuvering around the blaze. When trigger pressure is released the discharge is instantly shut off.

LEARNING THE CODE

Combination Radio Receiver Provides Practice

BUDDING hams, Boy Scouts, and others desirous of learning the code will be interested in "Echophone Commercial" communications receiver, Model EC-1. Not only does it provide for reception of both 'phone and code throughout its range of 545 kilocycles to 30.5 megacycles, but in addition has self-contained facilities for keying and code-reading practice.

With a standard telegraph key connected in series with the headphone the output of the receiver to the headphones will be broken up into dots and dashes as the circuit is keyed. If the receiver is tuned to a broadcast or other steady carrier, and its beat-frequency oscillator turned on, this output will be in the form of a heterodyne whistle. When keyed, the result is a perfect imitation of the sound of regular radio telegraph transmissions.

Listen in or practice

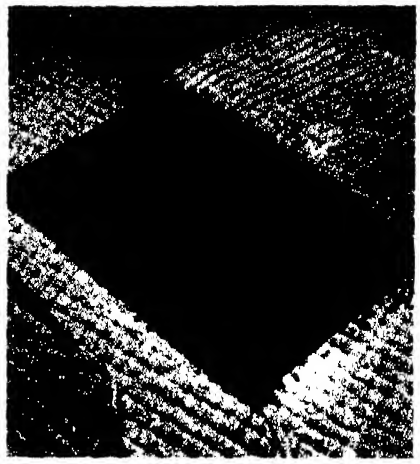
Group "copying" practice is possible if the headphones are placed on the table and the receiver volume turned up to make the sound audible over a reasonable range. Or, by connecting two keys in parallel it is possible to carry on two-way communication with either participant "breaking in" at will.

When some degree of speed has been achieved in code copying, then the regular code transmissions of commercial stations can be tuned in for actual on-the-air practice.

WET-PROOF

Electric Heating Pads In Rubber-Coated Fabric

GREATER safety in the use of electric heating pads is promised by a new rubber-coated fabric for wet-proof casings developed in the Du Pont laboratories. Since the new casing material is vulcanized, the edges of the pad's covering can be sealed with cement instead of sewn. Hence perspiration, moisture from wet bandages, or spilled water cannot soak through the bag, and the danger of short circuits from moisture penetration is eliminated. Careful cementing of the cord to the bag is an added protection.



Seams are cemented, not sewed

The rubber-coated product has been approved by the Underwriters' Laboratory, Inc., as the first material to meet their specifications for a thoroughly wet-proof casing. Tests require the material to stand in boiling water for an hour, followed by heating in an oven for 1000 hours at 100 degrees, Centigrade, and then by boiling for another hour.

GARDEN ANTS

Simple Treatment Eliminates Prolific Pests

ANTS annually do a lot of injury to lawns and gardens throughout the country. The galleries they form underground disturb plant roots; the earthern mounds which some species make during tunnelling operations are unsightly. It is, of course, quite useless to re-seed such areas until the ants have been completely exterminated from every part of their galleries.

There are many different species of these tireless pests. All species can, however, be effectively exterminated, it is claimed, with calcium cyanide, a material that has been thoroughly tested by entomologists and scientific investigators in this country and abroad.

Many different ant-exterminating formulas have been suggested, ranging from home-made remedies to commercially prepared baits and fumigants. By far the most effective is granular calcium cyanide which, on coming in contact with normally moist soil, liberates a gas that quickly penetrates throughout the galleries and kills

all ants present. If ants have infested the house, the line of their march should be traced back to the nest and the fumigant used at that point—*never* in the house.

Calcium cyanide in granular form is sold in metal cans equipped with spout, which serves as an applicator. This fumigant is very economical to use as only as many of the granules as would cover a dime are sufficient to annihilate an entire ant colony. The ground must not be wet, as burning of grass blades would result and it is recommended that the nests be probed with a thin stick to a depth of eight inches so that the Queen ant, living deep in the colony, may be eliminated. As soon as the granules have been injected into the nest, the opening should be closed with soil; in a few seconds all the ants in that nest will be killed.

As the calcium cyanide granules are placed directly in the soil rather than broadcast on the surface, this material offers no hazard to children or pets, especially as there is no poisonous residue after the gas is once liberated.

IVY POISONING

Dogs May Carry:

How to Prevent

MYSTERIOUS cases of ivy poisoning may often be traced to a pet dog, according to L. W. Kephart of the Bureau of Plant Industry. Dogs brush against ivy plants and bring home the chemically irritating principle on their fur. Whoever strokes the dog may come down with ivy poisoning. Ivy poisoning may also come from handling shoes or other clothes and tools that have been in contact with the plant. Poison ivy is most poisonous in spring or early summer when the sap is most abundant. But dry, dead plants, and especially the smoke from burning plants, can cause poisoning.

Poisoning may be prevented if the irritant is removed from the surface of the skin before it has time to penetrate. Wash exposed skin promptly with baking soda dissolved in lukewarm water and then with a thick lather of strong soap followed by a rinse in warm, running water. Baking soda, washing soda, borax, and photographer's "hypo" are all useful. Several washings in strong soap following the wash in an alkali solution will carry off the poison.

Industrial Growth

New Products and Processes That Reflect Applications of Research to Industrial Production

PRECISION FILING

Reciprocating Hand Tool For Semi-Skilled Labor

In a hand tool specifically designed for filing and recently made available by the H & M Research Company, there is practically no vibration transmitted to the hands

In action—no vibration

of the operator. Because the tool operates with a reciprocating action the operator does not need to move his arms. This eliminates the rocking motion which is a natural consequent of arm movement, even by experienced workers, when filing flat surfaces.

Using this new tool it is claimed that more accurate work can be done by an operator with little training than can be accomplished with an ordinary file in the hands of a skilled mechanic.

These tools are available in two stroke lengths — 3/8 and 1/8 of an inch.

THERMOSTAT

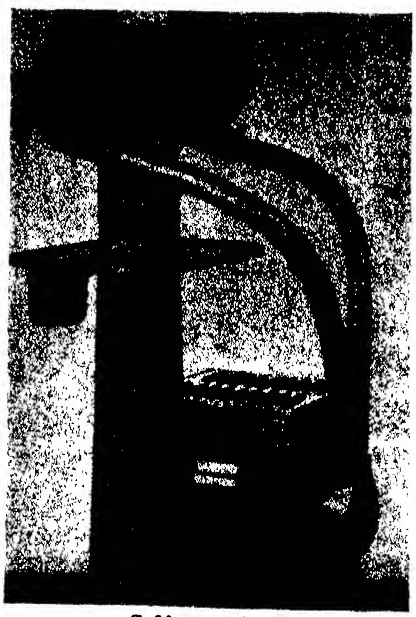
Operates Within Small Temperature Ranges

A new thermostat, which uses a brass bar in place of the more conventional bi-metal unit, depends upon the linear expansion of brass for its operation. This unit, announced by the General Thermostat Corp., is designed for use where accurate control of electric heaters is necessary. Vulcanizers, sterilizers, melting pots, flat irons, electric ranges, and a wide range of similar heating devices are some of the devices to which this thermostat can be applied. It is claimed that the linear expansion of a brass rod makes possible closer control of temperature than has been found with former types of thermostats. Thus it is stated that the temperature, with bi-metal thermostats, may use to as high as 150 degrees above the temperature setting before the thermostat turns the current off. These brass rod thermostats are available with differential ranges of 5 to 15 degrees, Fahrenheit, plus or minus. The maximum adjustable range of Positrols, as these devices are called, is 375 degrees, Fahrenheit.

DUST COLLECTOR

Self-Contained Unit Cuts Installation Time and Costs

Designed for use with various types of bench grinders, cut-off machines, polishers, buffers, and so on, a new and compact type of dust collector has been placed on the market by the Aget Manufacturing Company. This device, being entirely self-contained and not requiring connection to a centralized collecting system, may be moved from one machine to another, or a machine and dust-col-



Self-contained

lector may be moved as a unit.

Rated at 600 cubic feet per minute, the Dustkop 600, as this model is called, is equipped with a ¼-horsepower, 110-volt motor. Two types of intake flanges are available to remove dust from machines either singly or in multiple. The collected dust and dirt is removed by lifting the cover of the device, taking out the filter assembly, and lifting the pan in which the dust is collected. The filters employed are of spun glass.

CABLES

Welding Cables Are Flexible, Have Large Capacity

FLEXIBLE welding cables that make gun handling easier have recently been announced by Progressive Welder Co. In these cables the two current-carrying strands

For easier gun handling

are wound at steep helical angles to increase ease of flexing and to reduce wear. It is claimed that these cables have a capacity 50 percent in excess of conventional cables of the same size and increased life because of the extra heavy insulation employed. The water supply core of the cable is of flexible bronze tubing. Between the outer current carrying strands and the external abrasion-resistant cable covering is space for water circulation.

These new welding cables are available with a wide range of terminals for welding guns of standard make.

MARKING TOOL

Interchangeable Letters in Rotary Type Device

NUMEROUS installations of a new rotary or roll-type marking device on screw machines and turret lathes have shown their ability to automatically make clean cut identification marks in high-speed production. This marking tool, introduced by New Method Steel Stamps, Inc., is designed for rapid marking on cylindrical parts during production. The letters or figures in the tool are interchangeable.

The die is mounted in a holder which has a fine adjustment for

Marking tools, showing interchangeable letters and holders

starting the marking operation when brought into contact with the work. After completing the marking operation, the roll is returned to initial position by a coil spring mounted on the end of the roll shaft to which the die is keyed. The roll is so designed that continuous contact with the part after marking does not cause it to rotate and re-mark the surface. Only a single impression is made, even though the part continues to rotate before the roll is withdrawn from contact.

Various forms of holders are available so that the device can be adapted to most applications where the marking of rotating parts in production is required.

POLISHING WHEELS

Impregnated Soft Rubber In Wide Size Range

HIGHLY polished surfaces can be produced on any base metal, is is claimed, with a new type of soft rubber polishing wheel in which polishing compounds are impregnated in a special rubber binder. Five different types of compounds are available and, in addition, the wheels contain sufficient cutting grit to remove scratches and grinding marks from the piece being polished.

These new wheels, manufactured by the Chicago Wheel and Manufacturing Company, are available in a wide range of sizes and shapes. Conventional dressing tools are used to dress the faces of the wheels to any desired contour so that irregular shapes can be polished.

The material used in these wheels is not suited for polishing plated work.

Helicopter Records

Rotary Aircraft Operates as Seaplane Or Amphibian Helicopter

ALEXANDER KLEMIN

Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University.

AIRCRAFT designer Igor Sikorsky is continuing his pioneer work on the only single airscrew helicopter in the world with remarkable success. We have previously described this machine in our columns; the VS-300-A is a single-seater, equipped with a 90 horsepower Franklin engine, and with

Hovering aloft near the tree tops, Mr. Sikorsky demonstrates complete control over his single screw, 90-horsepower helicopter

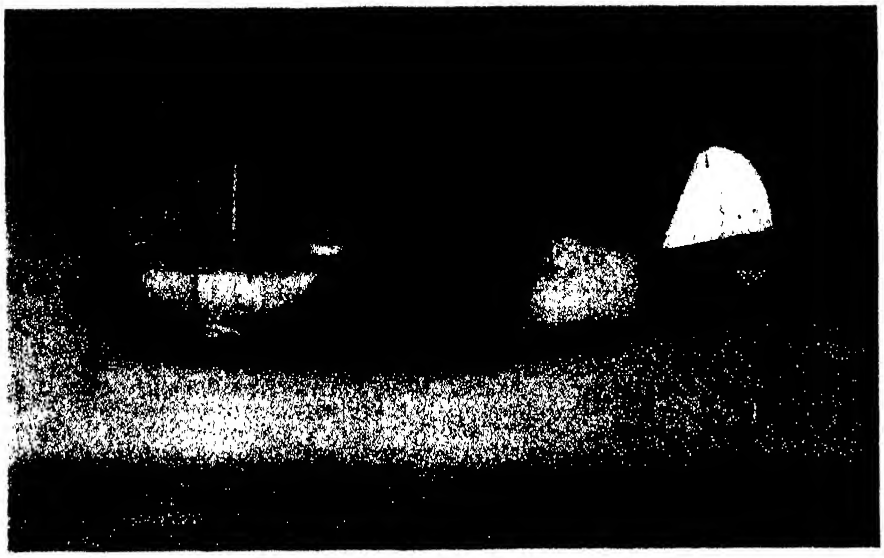
a gross weight of 1290 pounds. It has a three-bladed main rotor 28 feet in diameter and three two-bladed auxiliary tail rotors, each 92 inches in diameter. The pitch of all the rotors is controllable, providing maneuverability in flight. Power is transmitted through a multiple-belt drive so that alterations can be made rapidly and with flexibility. Quite recently two records have been gained by Mr. Sikorsky.

The first record was a splendid culmination of two years of development work. The craft hovered over an area of less than one acre for one hour, five minutes, 14.5 seconds, after having made a true vertical take-off with no ground run or climb at an angle. The descent and landing at the end of the flight were also truly vertical, and the machine was easily held aloft near tree tops. No matter how gusty the weather, the helicopter can operate from an area less than 50 feet square, although 20 or 30 feet more at the sides of the landing plot help against piloting error. It can be seen what possibilities this opens.

The second achievement lies in the fact that, with three cigar-shaped rubber floats replacing the landing gear, the VS-300-A was able to operate from the Housatonic River, and then to operate from land. Thus it has taken its position both as the first seaplane and the first amphibian helicopter.

The well-founded suggestion that rotary aircraft be provided for convoy work across the Atlantic, rapid progress on the Platt-Le page helicopter, purchase of Pitcairn-Larsen autogiros by the British, and other developments, in addition to the Sikorsky records, lead to the conclusion that rotary aircraft is about to come into its own. [On May 6 Mr. Sikorsky exceeded his own record, remaining in the air for one hour, 32 minutes, and 30 seconds.—*Ed.*]

Wheels replaced by pontoons



Aerodynamically clean—the Curtiss XSB2C-1 dive bomber

DIVE BOMBER

America Produces Outstanding Navy Plane

THE Germans claim much credit for their dive-bombers and dive-bomber technique. But it was the United States Navy which originated the technique and the Curtiss-Wright Corporation which built the first dive-bomber—the Curtiss Hell-diver, constructed in 1930. Now Navy and Curtiss-Wright together, instead of resting on their laurels, have produced a remarkable "super dive-bomber," the Curtiss XSB2C-I, which is shown in our photograph with armament carefully blocked out.

Aerodynamically, we can note the completely retracted landing gear; cabin with a windshield so low that the resistance of the streamlined fuselage is scarcely increased thereby; flaps to improve landing speed; slots at the leading edge, ahead of the ailerons, to maintain full lateral or banking control at low speeds when landing on the carrier's deck; the most efficient position of the wing relative to the fuselage, namely low mid-wing.

The power plant embodies a 1700-horsepower Wright Cyclone engine (the largest ever placed in a dive-bomber) and a full feathering three-bladed propeller.

Other features include unusually heavy armament; bomb load carried inside the fuselage to eliminate drag; wings that fold upward to facilitate storage on shipboard; and hydraulic operation of controls.

What is its performance? That is a secret, but, says Burdette S. Wright, Vice-President of Curtiss-Wright: "The new aircraft can carry twice as many heavy bombs as any existing dive-bomber, fly twice as far and attain a maximum speed of 100 miles an hour more than existing models." — *A. K.*

SELF-SEALING

Fuel Tanks Tested by Rough Treatment

SELF-SEALING fuel tanks are provided with a composition which closes the holes made by powerful machine gun bullets. However, because an airplane of the military type maneuvers so violently that the mere sloshing around of the gasoline inside the tank may cause damage, the B. F. Goodrich Company has developed a particularly rough method of testing such equipment in what is called a "slosh tester." The tank is mounted on a horizontal axis, and an arm, powered by an electric motor, oscillates the tank from 16 to 18 times a minute. A 25-hour test of a 425-gallon airplane container left no sign of damage.—*A. K.*

Slosh tester

CAMERA ANGLES

Conducted by JACOB DESCHIN, A.R.P.S.

Modernizing the Old Camera

THE story goes that Charles Belden, the cowboy photographer, has had such good success with his old style camera that when it came a-cropper once and had to be sent away for repairs, he insisted on waiting for his

Figure 1: **About to go modern**

old love and discouraged all attempts to entice him to adopt one of the newer models. That is not as unusual a case as it may seem in these days when there is such a large and attractive array of camera offerings in every size and style. For sentimental and other reasons, the owner just can't bear to let the old camera go. After all, it's taken some swell pictures;

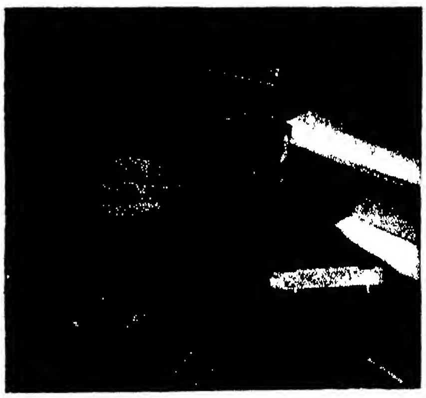


Figure 2: **Bed adjustment**

why borrow trouble when you can let well enough alone? Okay, brother, but how about bringing your old camera up to date? In this way, you can eat your cake and have it, too.

Among the principal signs of the modern camera is the range finder and the flashgun. Both of these can easily be installed on many cameras, thereby putting your old camera into step with advances in the industry, and making it a more flexible and efficient unit to use in the pursuit of your chosen hobby.

Figure 1 shows a type of camera ideally suited to range-finder installation. There are many varieties, many sizes, but a little study usually reveals the simple mechanical details required to do the job efficiently. It has been found, in fact, that modernizing the old camera in this way usually reveals that the infinity stop is in the wrong position anyway, so that the range-finder installation procedure becomes a double-edged benefit, a check on the accuracy of the infinity mark, and a correction of it, if a fault exists.

Figure 2 shows the first step involved in the installation of a Kalart range finder, that of coupling the movement of the finder with the movement of the bellows along the bed of the camera. When completed, the range finder will focus as closely as 3½ feet, and will automatically uncouple, or free itself of the camera focusing arm when it is desired to focus at closer distances. In that case,

Figure 3: **Range finder goes on**

the camera is operated in the normal manner, that is, by means of the camera ground glass or some measuring method.

Incidentally, while it is usually recommended that the range finder be installed by the makers, thus necessitating sending your camera to the factory, the details of installation are so simple that a kit of tools is supplied to make it possible for you to make your own installation. An easy instruction manual tells you just how.

The camera body is prepared to take the range finder and the latter permanently attached, as shown in Figure 3. The operating arm that will allow the range finder to work synchronously with the camera is on the bench near the end of the camera bed, ready for attaching.

In Figure 4, the operating arm is shown being attached in the final stages of the coupling process. Just ordinary care is required to do the job right, such as checking the focus and correcting the position of the in-

finity mark, if this is necessary, as it usually is, we are told. The camera is now ready for use, equipped with a method of focusing that is universally acknowledged to be the most accurate we know today.

The second improvement is the flashgun. Figure 5 illustrates a Master Kalart Synchronizer mounted on a bracket next to the range finder. Because of the precision operation

Figure 4: **Coupling the range finder**

of the range finder, it is important to have a supporting bracket for the flashgun that is independent of the range-finder mounting. In this particular case a bridge-type bracket has been installed on the camera around the range-finder casing, the bracket being attached to the camera body in such a way that it is absolutely free of the range-finder at all points. Thus, the flashgun mounting introduces no strain or weight whatever on the range finder. When not in use, the flashgun and tripper (attached to the shutter, as shown) are simply taken off, leaving only the bracket as the permanent attachment.

With range finder and flashgun, your old camera becomes as good as new insofar as modern improvements are concerned, and you are equipped to compete on equal terms with the best of the new cameras.

Efficiency of Light Reflectors

Designers and manufacturers of reflectors for photographic lighting units are concerned principally with the shape of the reflector, its precise curvature, which is made to a mathematical formula, and the material used. If the material is inferior from the point of view of efficient reflection, results will be poor. Available materials vary in this respect, some reflecting more, some less light than others. The volume of light reflected from any given surface as compared to the incident light, that which strikes the surface of the material, is called the co-efficient of reflection. For example, if a material is said to have a co-efficient of 80 percent, this

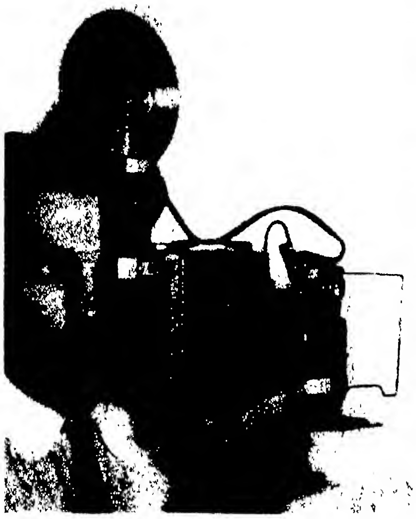


Figure 5: **The finished job**

means that it reflects 80 percent of the light that hits it. General Electric Company's "Illuminating Design Data" gives the following percentages for various materials:

Material	*Co-efficient of Reflection*
Glass mirror	80% to 90%
Specular Alzac (also called Alcite)	75% to 85%
Rhodium	70% to 78%
Polished aluminum	60% to 70%
Specular chromium	63% to 66%
Specular nickel	60% to 62%
Brushed aluminum	55% to 57%

Temperature Standards

New Agfa instruction sheets designate a revised temperature standard of 68 degrees, Fahrenheit, (20 degrees, Centigrade) for the development of Agfa films and papers. Former recommendations were 65 degrees for films, 70 degrees for papers.

"Chief among the reasons for establishing the new temperature standard," says the Agfa announcement, "has been the desire to simplify existing separate recommendations on film and paper development which have in the past been a source of some confusion. Related to this condition has also been the realization that developing solutions can usually be maintained more easily at 68 degrees than at 65 degrees."

The Camera Goes Fishing

Good fishermen, they tell us, don't have much time to use their cameras because they're busy catching fish. But recently we ran across a little pamphlet on "How to Photograph Your Fishing Trip," evidently by a writer who knows his fishing as well as his camera, and it appears that a man can be a good fisherman and still take pictures; you can see for yourself by writing for a copy to Hood Rubber Company, Inc., Watertown, Massachusetts. The booklet was compiled with the assistance of

no less an authority than the photographic editor of *Field and Stream*, and is really a little treatise on taking pictures, its general principles being applicable not only to fishing, which it discusses specifically, but to many other activities as well.

Cutting Heads Gracefully

If you must cut into heads, because of lack of parallax compensation on your camera plus a too-close viewpoint, or for any other reason,

"Peek-a-Boo!"

you can sometimes get away with it by introducing an idea, as in this case. The tilt of the child's head gives the impression that she is looking out from underneath a low "ceiling" and the idea of "Peek-a-Boo" comes instantly to mind.

The Baryta Coating

Usually taken for granted, particularly by amateurs, the baryta coating on photographic paper is most essential as a protection for the emulsion coating against possible impurities in the paper base as well as to ward against the tendency of the wet emulsion to soak into the paper and thus produce a flat image. The baryta coating is a mixture of barium sulphate and gelatine solution and when applied to the paper forms a smooth surface.

Too Many Colors Spoil the Picture

The average photographer, whether amateur or professional, is inclined to bunch a lot of different colors in one shot when attempting color photography for the first time, says Valentino Sarra, prominent American photographer. Speaking at the recent Westinghouse Photographic Lighting Conference at Bloomfield, New Jersey, Mr. Sarra advised simplicity both in the composition and color selection. In fact, he related that he has even gone so far as to use only one color both for subject and background. All

Over $1100 in Prizes

Sixth Annual Scientific American Amateur Photography Contest

Popularity of the divisional method of judging photographs in the Scientific American Contests, as determined by the enthusiastic response in past years, has been so great that the method is once more being used for the Sixth Annual Contest. In each of the divisions listed below there will be awarded seven major prizes and five honorable mention awards, a total of 36 prizes in all.

Complete rules of the contest will be found on page 368, June issue, Scientific American.

Divisions In Which Prints May Be Entered

Division 1. Human interest, including camera studies of people, animals and so on. Portraits will be grouped in this division.

Division 2. Landscapes, including all scenic views, sea scapes, and so on.

Division 3. Action, including all types of photographs in which action is the predominating feature.

The Prizes

1st. Three $125 LONGINES, Coronation Model, Solid Gold, Men's Wrist Watches.

2nd. Three $90 LONGINES, Presentation Model, Solid Gold, Men's Wrist Watches.

3rd. Three International Marketing Corporation PHOTOTRIX "22" Enlargers, complete, less lens. (List price $54.)

4th. Three Burleigh Brooks FOTH-DERBY Cameras, with built-in coupled range finders. (List price $34.75.)

5th. Three WESTON No. 715 Exposure Meters. (List price $24.)

6th. Three ABBEY Vimo Flash Guns. (List price $13.75.)

7th. Three Raygram LEE Timers. (List price $12.50.)

Five Honorable Mention Awards, each to be a new or renewal subscription to Scientific American for one year.

Address all Entries to

Photograph Contest Editor, Scientific American

24 West 40th Street New York, N. Y.

the facts of color may be found in books, he advised his listeners, and the worker who essays color photography has three things to do: work hard, be reasonably intelligent, and acquire an appreciation for color values and relationships based on much study and experimentation.

"Red Light" Pictures

ONE way to while away the time of waiting for the red light to change to green so you can proceed motoring on your way, is to use the camera, as we have done in the reproduced illustration. We always carry our

"Red Light" picture

camera by our side so when an opportunity like this faced us, the late afternoon sun shining strongly on a truck load of bags of something or other, we aimed and banged away to get this study in strong contrasts. Often the subject-matter may be more striking, particularly when there is some human interest mixed up in it. It is always a matter of chance, of course, and you are very limited, but there is likewise the alternative of shooting if it looks good and saving your film if it doesn't. It's worth watching for, though, and the only way to make sure to get the good ones is to have the camera handy.

Freezing Out Glare

ASKED once to photograph a silver loving cup, after several other attempts had been made to get rid of the glare shooting out from various points on the subject, John H. Cornwall relates that he overcame the difficulty in a very simple manner. He asked and received permission to borrow the cup for four hours and upon reaching home placed the cup in the ice box. After remaining there for some time, the surface had acquired a nice matt coating, which was ideal for photographic purpose. Immediately after removing the cup from the icebox Mr. Cornwall set it up and photographed it, having previously made lights and camera ready for the

shot. The resulting print was so successful that he was able to sell quite a number of duplicate prints, totaling about $75 for the job.

Dry Negatives by Infra-Red

When seconds count, the "sealed-silver" infra-red heat lamps now available for drying negatives will do the job within two minutes. Radiating infra-red rays, the Birdseye lamp works without a reflector

Left: **Clear glass and (foreground) "sealed-silver" heat lamps.** *Below:* **Set-up for drying negatives using two lamps and a fan**

because it has its own built-in reflecting unit in the form of a silver lining sealed inside the bulb. When directed at a wet negative, the rays penetrate through to the base of the film, according to the makers, and start the drying process from within, thus cutting down drying time considerably.

The illustration shows the method. The wet negative is suspended between two lamps placed about two feet apart. An electric fan is placed behind the negative to send a flow of air across the path of the rays on each side of the film.

"Old negatives that have been ruined by watermarks caused by improper drying can be restored," suggest the makers, "by resoaking them for about 30 minutes in a suitable 'wetting' solution, rinsing them in water, and then drying with radiant heat lamps. The lamps can also be used in the same manner for drying photographic prints, and in many commercial applications such as for drying photographic solutions painted on glass. During the hot summer months especially, when solutions are slow in drying unless in an air-conditioned room, infra-red lamps do the work in a few minutes."

Channeling Emphasis

The unfortunate tendency of many still photographers of trying to take in the whole business instead of concentrating on a portion of it, is to some extent a fault of many movie makers as well. "But I want to tell the whole story, give an idea of the whole works," the movie-maker might say.

Our reply to that one is: You can tell a better story by picking out a representative segment than by including everything in the camera view. The most effective way of doing this, if you must give a picture of the whole business, is to panoram the many points of interest involved and then channel down to just one aspect and concentrate all your efforts on that one. The story will be much more effective than if you attempt to cover too much ground. Diffusion of interest results and, because emphasis is lacking, the story lacks punch and interest.

Small Trimmer

For general purposes, a trimming board that will accommodate the largest prints you make is, of course, indispensable. However, there are many occasions, as in the case of small contact prints for filing or other uses, when a smaller trimming board will be found more convenient. Every worker knows what a nuisance it is to cut a small strip of paper or trim a small print on a large trimmer. The task seems awkward and cumbersome; with a small trimmer it is easy. A small trimmer costs very little; in view of its handiness, it seems a good investment.

Folding Prints

Where it is desired to fold a print, as in the case of greeting cards, the usual recommendation is to employ one of the "documentary" type papers sold under varying names by the different paper makers. These papers are thin, however; double-weight papers are more desirable for cards. A simple method makes it possible to fold any paper without cracking at the fold. After determining the position of the wanted fold, take a straight edge and a razor blade or other sharp cutting tool. Place the straight edge and then cut carefully through the emulsion. A really sharp blade will do this without cutting too deeply into the paper base itself.

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WHAT'S NEW

In Photographic Equipment

New Wabash Superflood Bulbs: Useful life of No. 1 increased from two to three hours, that of No. 2 from six to eight hours. Tests said to show new-type bulbs maintain efficiency better than old type; tendency of flood bulbs to lose considerable light output after prolonged use has been minimized.

Varigam Gelatin Filters (Set, $1.00, $2.00): Special type gelatin filter for use with Varigam contrast-control enlarging paper. Individually mounted in rigid cardboard holders with 2-inch filter opening. Numbered 1 to 10, mounts simplify use of paper. Three combinations: Set 5-A, Filters 1, 3, 5, 7, 10; Set 5-B, 2, 4, 6, 8, 9. Set 10-C, Filters 1 through 10. Filter selected to use over enlarging lens to produce contrast desired. Splitting exposure by using two filters each for half total exposure time extends range of contrasts obtainable.

Leitz Cover Glass Plates in Laboratory Packing ($7): Package contains 600 Leitz Cover Glass Plates. Ground edges permit slides to be made with greater rapidity. New package offered as a convenience to professional and scientific laboratories and others who make large numbers of slides.

Speedgun Model F ($25, complete with two-cell battery case with extra segment for third cell, three battery cells, seven-inch adjustable aplanatic reflector and soft moisture-proof bag, L arm for attaching to camera, and all-metal cable release): Designed for use with Leica and Contax cameras. Uses L arm attaching-bracket, screwing into tripod socket, leaving accessory clip free for use of finders, and so on. Permits use of side, extension, and accessory lighting.

The new Mendelsohn Speedgun, Model F

Educational Films on Sweden, 16mm (lent free except for nominal handling charge): Distributed by Swedish Travel Information Bureau, 630 Fifth Avenue, New York City. Subjects cover various aspects of Swedish life. Available booklet lists films which are offered to universities, colleges, high schools, and other educational institutions, as well as to clubs, churches, and individuals. "Edited from abundant material received from Sweden," say distributors, the sound films are all provided with adequate and authentic commentary and musical accompaniment. The silent versions are provided with informative titles. All the films are non-political in character and aim only at presenting life in Sweden and the cultural and social development of its people. They are 16mm size and, unless otherwise indicated, are in black and white. They may be borrowed for single showings against payment of transportation costs both ways and a small handling charge to provide for replacements and repairs. Educational institutions are invited to write in regard to purchase copies or long-period rentals.

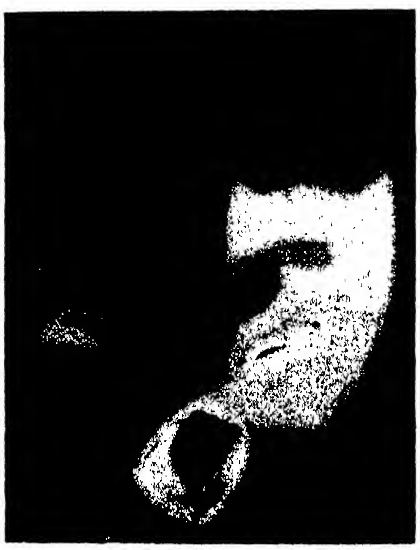
Conducted by A. D. RATHBONE, IV

INTEREST IN FIREARMS *is traditional with American men; fishing tackle is a requisite of one of the world's oldest occupations. Scientific development of guns and tackle, in the use of which millions yearly find sport and recreation, fathers this monthly department which welcomes correspondence from readers.*

Boots to Fit the River

IN some sections of the United States chest-high waders are the only sensible river apparel for the trout fisherman; in others, maximum satisfaction and comfort are to be found in hip-length boots. And we've seen many times when, whichever we had, we wished for the other, so now, on any extended angling trip where stream wading is a factor in success and pleasure, we take both the waders and the hip-boots. Often that procedure has brought satisfaction and fish which might not otherwise have been ours.

Carrying both waders and hip-boots to a trout steam is simpler than it would have been a decade ago. Modern leg protection in both styles is composed of more flexible material. So flexible are the boots, in fact, that they may be turned completely inside out down to the insole to permit thorough and complete drying, an impossibility with either the old-time, stiff, canvas waders or the board-like bottoms of early-day hip-boots. This pliability and lightness has contributed much toward reduction of fatigue on trout fishing trips. The saving of a pound or two in wader weight during a long day in the stream means as much to the angler as does the lighter field gun to the hunter who tramps hills and swales. Illustrative of this weight factor are the following figures: a pair of "old-time" hip-boots weighed upwards from 6½ pounds; a pair of Goodrich



Old and new drying methods

"Litentufs" weighs 5½ pounds, in the same size; a pair of "old-time" waders, 7¼ pounds; 1941 style Goodrich Wader Top Boots, 6 pounds.

Like the most productive trout flies, the argument on boot-foot waders versus the stocking-foot type, plus wading shoes, goes on unabated and boils down to being largely a matter of personal preference. As we've noted, basic construction of fishing footwear has scientifically advanced

Save a pound—save energy

until today either style offers wearing qualities, comfort, and protection far in excess of the boots of our fathers. River water, however, is still as wet and as uncomfortable as of old, when it trickles down a leg. Today, thanks to his automobile, the fisherman is not restricted to working only one stream, and in a day he may pursue the phantom Lady Luck in many waters of varying conditions. With our pair of "hippers" rolled into a neat 8-inch bundle and tucked away in a corner of the car, it's no trick to change from waders to "hippers" at the stream-side during the heat of the day, or when our angling takes us into shallow waters.

We've an abundant supply of two interesting booklets by Goodrich Footwear Division of Hood Rubber Company entitled "Letters Found in an Old Tackle Box," and "How to Photograph Your Fishing Trip." They're free and full of information on boots and fishing. Want a couple?

He Learned to Shoot

FROM C. M. Hawley, of Caldwell, New Jersey, came a note which read: "I am enclosing story of a little experience that came my way and think it may be of interest to

many of your readers. The boy in this story thought he had made a new discovery; it was merely an old truth he had uncovered for himself." We believe Hawley's story so well typifies characteristics of good shooters that we reproduce it, as follows:

I met him one day while hunting for rabbits. A nice looking farm lad in his early 'teens, he was coming down a hedgerow and I could see he had game in his hunting-coat pockets, but no gun or dog in sight, so I stopped for a chat and inquired how he did so well without a gun. He told me he never hunted with anything but a handgun and produced a .22 automatic from a shoulder holster. This was interesting, and to learn more I asked if we couldn't work along together, to which he readily consented. A large brush pile in an old orchard produced a cotton-tail. Out came the Colt and in a flash the bunny flopped over and lay still, as pretty a shot as you could imagine.

In reply to my questions it seems the lad had had determination and not much else to begin with, but he won out over all handicaps. "I live in the country," he said, "and at times it gets pretty monotonous. But I have always had a great love for guns, especially the pistol, and my thoughts turned in that direction for entertainment, so, why not make a game of it? Why not try to become an expert wing shot?"

How to start was his problem. It had to be a way that did not cost much, and that meant an air rifle, and while practice of that sort was not what he had in mind, it would have to do, so he bought the best one he could afford, with lots of BB shot, and went at it for all he was worth.

"Nothing was a target unless it was moving," he explained, "and I think now the air rifle was just the thing at that stage of the game, because when shooting at a tin can against the sky, I could see the shot in flight and it helped to correct my aim so I was registering hits quite often, and that was encouraging.

"I kept this up until I was hitting the target nearly every time—then made the great discovery: I was *not* using the sights of the gun, just pointing and squeezing the trigger. I was tickled pink, for this was what was meant when they spoke of 'shooting by instinct,' the secret of pistol shooting at moving targets. It all made sense. Just like driving the car or tractor, you do not have to keep your mind on hands or feet—they do the thing the brain dictates, by instinct."

Deciding he would now graduate to powder burning, the lad managed the purchase of a single-shot .22 caliber pistol and all the ammunition the pocket book would stand. To take off some of the strain of throwing the targets, he rigged up a swinging target like those in shooting galleries, and as a variation he made a target of an iron ball, suspended from the spring of an old curtain roller, to give it lots of jump.

He practiced on all kinds of moving objects, such as rats and mice around the barn and corn cribs. "There's never a dull moment since," he said. "When I had enough confidence in my ability, I invited my father out to see me do some shooting. Well, he was properly impressed, and it cost him money. He bought me a .22 Colt automatic and a case of ammunition. I do all my hunting with this gun and I never shoot at any game that isn't moving."

The art of markmanship at the present time is an accomplishment. The day may not be far distant when it will be a necessity, so if you like to shoot, get out the old gun, shine her up, and go to it. If you have the determination, you are a sure bet to win.—*C. M. Hawley.* [Has anyone else a story? Forum is open.—*Ed.*]

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POT-SHOTS

At Things New

United States Electric Manufacturing Corporation offers new "Swivel-Head" flashlight of standard two-cell capacity which should find a warm welcome from fishermen, campers, hunters—in, fact, just about everybody. Stoutly built with clip for pocket or belt attachment, with snap-back bottom ring hanger, three-point safety lock switch, unbreakable plastic lens, its cardinal appeal to the man of the outdoors will be the flexible pivoting of the light beam made possible by the swiveling of the head. Hung from a tree or tent pole, snapped to the belt, or stood on end, the head of the lamp can be swiveled to flood light on any night chore. Would you like a folder?

Flexible head rotates beam

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with a list of available titles, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for.

UNITED WE STAND

By Hanson W. Baldwin

CALM, cool, objective, poised, also comprehensive, detailed analysis of the factors involved in the defense of the Western Hemisphere, by one of the few writers having broad enough background to assess so vast a subject—the military and naval expert of *The New York Times*, an Annapolis graduate. Without sensationalism or emotional appeal he dissects the mistakes of the Allies and applies the findings to our problem; describes the probable nature of a war with Japan; lays the bogey of invasion; discusses our Navy, not disconcertingly; discusses our air forces and our Army (a bit disconcertingly). Throughout he gives a large amount of definite and trustworthy factual data. Readers who prefer tub thumpers, exaggerators, and over-estimators, also under-estimators, may not like this book. (364 pages, 6 by 9¼ inches, one chart.)—$2.85 postpaid.—*A. G. I.*

BUILDING AND FLYING MODEL AIRPLANES

Published for Air Youth of America

DETAILS of every step in building and flying model airplanes are described in this completely up-to-date book. It goes thoroughly into such matters as materials and tools, how to construct various parts of the planes, props, wing and fuselage coverings, gasoline-powered models, and how to fly these tiny planes. (250 pages, 5½ by 8 inches, many drawings and photographs.)—$2.10 postpaid. —*A. P. P.*

SO YOU'RE GOING TO FLY

By James L. H. Peck

OF the many books on aviation, this is one of the soundest and most modern; it is destined to be exceedingly popular. The author has not exaggerated, has presented the truth clearly and interestingly. A sober statement on aviation as it really is today, it offers an excellent picture of principles of elementary flying, of what flight instruction means, and deals with such vital topics as blind flying, air power for defense, modern military aircraft formation, and combat, with an illuminating chapter on aerial gun fire and bombing. While emphasis is on military aviation, concluding chapters give some attention to commercial flying, with a fair picture of the industry busily at work constructing planes and engines. Glossary, bibliography, and useful information for those who wish to enlist in flying forces complete the discussion. (240 pages, 5¼ by 8 inches, 20 illustrations.)—$2.60 postpaid.—*A. K.*

RIFLE MARKSMANSHIP

By Lt. William L. Stephens, Jr.

HAVING been actively engaged in .22-caliber rifle shooting for 15 years, during which he has acquired several national championships, the author is adequately equipped to teach others how to shoot. This book is designed to start the youngster—or the oldster—off on the right path. It is simple, direct, straightforward talk, minus technical expressions, on how to shoot a small caliber rifle, beginning with the encouraging chapter heading, "You, Too, Can Become an Expert Marksman," and leading on through progressive stages of range and target shooting. A particularly splendid book for Young America in these days of preparedness for national defense. (88 pages, 6 by 9 inches, 20 line drawings.)—$1.10 postpaid.—*A. D. R., IV.*

HOW TO BUILD AND EQUIP A MODERN DARKROOM

By Nestor Barrett and Ralph Wyckoff

MR. BARRETT is an instructor in photography and Mr. Wyckoff a practicing architect of over 35 years' experience. Such a combination should be enough to commend a book on the subject of darkroom building without any further comment, and a perusal of the book's contents, with its many clear and helpful drawings and photographs, confirms the first impression. Whatever your goal in the way of a darkroom, this book provides an excellent and reliable source for ideas and guidance. How-to-do-it instructions are included for building an apartment darkroom, a built-in darkroom, and making a de luxe photographic installation for both still and motion picture work. Various chap-

ters deal with floors, walls, and ceilings, ventilation, darkroom lighting, sinks, drainage and water supply, and so on. Available products are listed and prices are mentioned in the belief that such information is needed by the amateur in planning construction. (133 pages, 6¼ by 9 inches, illustrated.)—$2.10 postpaid.—*J. D.*

BAIT CASTING

By Gilmer G. Robinson

THERE'S more to the art of bait casting than meets the casual eye, as will readily be recognized after reading this excellent treatise. But after you've covered chapters on "Fundamentals of Casting;" "The Beginner's Equipment;" "Tips on Fishing;" "Bait;" "Fresh Water Game Fish;" "The Sport of Bait Casting and Fishing," you'll not only feel you are an authority, but also you will be sure to enjoy bait casting as it should be enjoyed. The best part is that with reasonable practice of the author's instructions, that authoritative feeling should be justified. (66 pages, 6 by 9 inches, 26 illustrations.)—$1.10 postpaid.—*A. D. R., IV.*

LITTLE BITS ABOUT BIG MEN

By B. C. Forbes

INSPIRATIONAL anecdotes and stories of modern leaders, illustrating the tenacity, industry, or ingenuity with which they followed their chosen paths and achieved success. This makes fascinating reading even for successful men who have no need for the encouragement it offers. (223 pages, 5¼ by 7¾ inches.)—$2.60 postpaid.

BIRD PORTRAITS IN COLOR

By Thomas Sadler Roberts, M. D.

SELDOM has such an author-illustrator combination been achieved as in the presentation of this complete and magnificently illustrated volume on birds. The author is Professor of Ornithology and Director of Natural History at the University of Minnesota. The illustrators, whose paintings were checked with the actual bird skins before being reproduced in full color, are Allan Brooks, George Miksch Sutton, Walter Alois Weber, Francis Lee Jaques, Walter John Breckenridge, and the late Louis Agassiz Fuertes. No more authoritative group of ornithologically trained men could conceivably have been drawn together. The full page illustrations, unsurpassed in color brilliance and tone accuracy, help to make this volume, which covers 295 species with 561 major figures shown in plates, a publication without a rival in popular bird books. If you would know your feathered visitors by sight, make this book your constant companion and reference. (200 pages, 8½ by 11 inches, 90 full-color page plates.)—$3.60 postpaid.—*A. D. R., IV.*

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

PORTABLE telescopes are not uncommon but the one in Figure 1 has an uncommon feature—its weight may be shifted from wheels to legs; and, later, when it is desired to trundle it back home or indoors, the weight may be shifted back to the wheels.

W. H. Keister, 415 California Ave., Oakmont, Pennsylvania, is the maker and he says that, when he at first simply attached casters to the tripod legs, they proved too small and did not roll well. The retractable running gear consists of rubber-tired wheels from a boy's coaster, mounted on a U-shaped frame and hinged to the base of the tripod. To shift the weight to the wheels the handle on the U is raised, which also locks the U in position. A tongue for towing the telescope about is attached to the third foot of the tripod. The latter rests at all times on a caster. The telescope is a 6" reflector, of clean, solid design, and it weighs about 200 pounds. The finder is a second-hand, Navy gun sight.

ONE more of Walkden's "Richest-field" telescopes, an "RFT" of 6" aperture, made by Fred W. Forrester, 252 Lemon Ave., Arcadia, California, is shown in Figure 2. It has a hexagonal tube made of 1/4" plywood. The eyepiece lenses are coated with fluorides, to eliminate the ghosts (optical ghosts, or ghost images). "I think the RFT is great," Forrester enthuses.

CLUB: Clyde W. Tombaugh, Lowell Observatory, Flagstaff, Arizona, the amateur telescope maker who found Pluto, in order to obtain 16" Pyrex disks for other amateurs at a relatively low cost, offers to sponsor a "Sixteen-inch Club" which, if it obtains 20 members within six months, will be able to purchase such disks at only $35 each. Regular price for this size, solid type, where single disks are purchased, has been more than $100 higher, because the high cost of producing single disks is chargeable mainly not to the glass or to the pouring, but to making the mold. Corning Glass Works, Corning, N. Y., has agreed with Tombaugh, the sponsor, that it will receive checks for $35 each and hold the funds six months or until 20 orders have come in, then make the disks: failing this, refund the moneys. Three orders are lined up already.

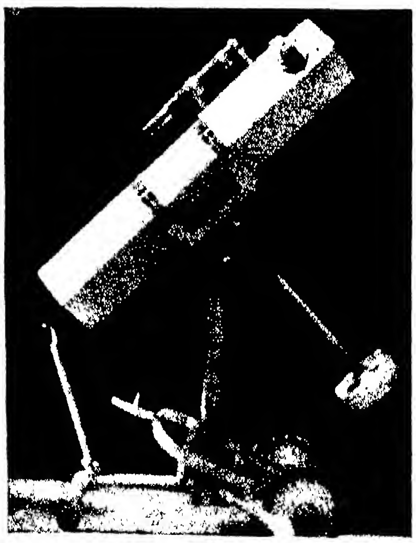

Figure 1: **You trundle it**

Figure 2: **A hexagonal RFT**

Tombaugh has also ascertained that Pittsburgh Plate Glass Company, will supply 16" tool disks of 1 1/4" plate, boxed, f.o.b. factory at Ford City, Pennsylvania, at $7.80 each.

There's a lot of difference between a 16" and a 20", not alone in weight of the disk, where the 20", if worked without a machine, is a real backache, but in bulk and cost of the mounting, for the mass ratio between the two is almost as one is to two (calculating from the cubes of the respective diameters). The 16" size should afford a pretty telescope, big, impressive, powerful, yet not too big. For many, a 20" is.

STELLAFANE convention, Saturday, August 2.

ADVANCED amateurs and groups who are planning rather large reflectors will find a cleanly designed 24" described in Vol. VIII, No. 6, of the Publications of the Observatory, University of Michigan. This publication, while not available for general distribution, may be consulted at astronomical observatory libraries. The 24" (Figure 3) was designed by Robert R. McMath and George H. Malesky, of the staff of the McMath-Hulbert Observatory. The former is an amateur telescope maker and astronomer (motor car manufacturer) who turned professional and is widely known for his tower telescopes, his spectroheliokinematograph and other instruments, at Lake Angelus, Pontiac, Michigan, also for his educational motion pictures of the planets and of solar prominences. The new telescope will be used first for doing over these films, with the greater resolution it affords.

The skeleton tube is made of longitudinal struts of 13-gauge steel having box sections. The center ring is made of six pieces welded together in box section. The tube assembly has proved to be very rigid. The tube center section and cell are of 3/16" rolled steel with ring flanges, the assembly welded and thrice annealed.

The 24" Pyrex primary is an $f/4$ and there are two secondaries of 3 1/2" and 5 1/2" diameter, to give, respectively, $f/25$ and $f/50$. The primary was figured by Halley Mogey, of the Perkin-Elmer Corporation, and tested by Dr. Heber D. Curtis, who reported it an unusually fine surface. The two high-magnification secondaries pre-

Figure 3: **Reflector at Lake Angelus**

sented real difficulties and E. L. McCarthy, now optical designer with the Perkin-Elmer Corporation but formerly an amateur (see "A.T.M.", page 389), feeling that the conventional tests were inadequate, proposed a new test which eliminates the combined testing of primary and secondary. This was used by Halley Mogey to test the secondaries, and proved to be an unqualified success, according to McMath.

This new "McCarthy test," as we suggest it be known, is described by McCarthy as "A New Test for Convex Surfaces," in the *Journal of the Optical Society of America*, February 1941, pages 107-108, as follows:

WHENEVER the object or the image point of a reflecting surface is virtual, as in the case of a Cassegrain secondary mirror, testing is more of a problem than it is when both conjugates are real. Ideally, the test should permit a complete view of the surface at a convenient angular size; it should not involve large and expensive auxiliary pieces; it should not depend on slow measurement of zonal foci, but it should produce a simultaneous darkening over all parts of a perfect surface when a Foucault knife-edge is introduced.

"These conditions are reasonably well met by the system shown in Figure 4. Light from an illuminated pinhole passes obliquely through two plane-parallel glass plates to a silvered spherical mirror. Reflected first from the sphere and then from the large plate, the light converges toward the virtual focus of the secondary mirror, which returns it through the plate to a real focus at the knife-edge. These two foci, of course, represent the conjugates for which the secondary mirror is to be free of spherical aberration in actual use.

"Since the large plate has a considerable thickness, it introduces serious aberration into the beams of light diverging and converging through it. It is the function of the two small plates to cancel the unsymmetrical aberrations such as lateral color and coma. To effect this compensation, all three plates are of the same thickness, and the small ones are set at the same angle to the axis as the large one, but in the sense which restores the displaced axis. The longitudinal aberrations, such as astigmatism and spherical aberration, are augmented by the small plates and must be removed in a different manner. If the pinhole is displaced from the center of curvature in a radial direction, either toward or away from the spherical mirror, aberration is introduced of the proper sign to cancel the spherical aberration of the plates. Astigmatism is compensated by displacing the pinhole laterally with respect to an axis of the sphere, since the astigmatism in the field of a concave sphere is of the proper sign to cancel that of the plates.

"Obviously the conditions will be

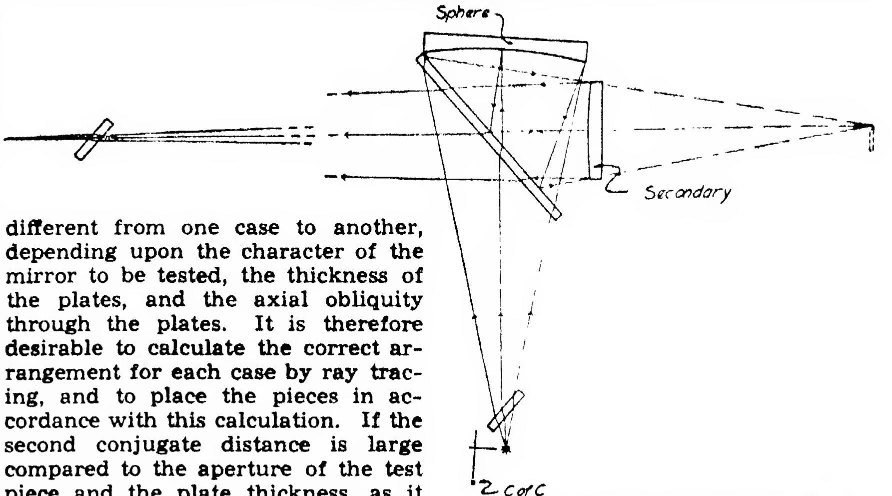

Figure 4: **The McCarthy test**

different from one case to another, depending upon the character of the mirror to be tested, the thickness of the plates, and the axial obliquity through the plates. It is therefore desirable to calculate the correct arrangement for each case by ray tracing, and to place the pieces in accordance with this calculation. If the second conjugate distance is large compared to the aperture of the test piece and the plate thickness, as it usually is in a Cassegrain, no calculation is necessary. Instead, the adjustments may be made by trial until the beam of convergent light reflected from the large plate is shown by the knife-edge test to be homocentric. In such a case, of course, the secondary to be tested is temporarily removed in order not to interrupt the beam. This method of adjustment assumes that the final passage through the large plate will introduce no appreciable aberration, and it is justifiable in the case of a slender emergent beam. Whether it is good enough for a particular case may be tested by examining the effect of the final small plate. If its presence or absence makes no observable change in the character of the final image, other than a displacement, the indication is quite definite that the trial and error method of adjustment is suited to the particular case, inasmuch as the aberrations of a plane-parallel plate are constant, no matter where it happens to be along the axis.

"An illustration is provided by two Cassegrain secondaries made for the McMath-Hulbert 24" telescope. Primary and secondary mirrors were made by Mr. Halley Mogey, who also introduced improvements over the original idea of the test. The primary is $f/4$ with a central hole 4.5" in diameter. The secondaries are 3.5" and 5.5" in diameter, and give magnifications of 12.5 and 6.5 respectively. The combination of large central hole, high magnification, and large unvignetted field made it impossible to see any error on the secondary mirrors when tested by the Ritchey method, even before any figuring at all had been done.

"The test pieces, also made by Mr. Mogey, were a spherical mirror of 9" aperture and 24" radius of curvature, a plane-parallel plate of 12" diameter and 0.5" thickness, and two small plates 0.5" thick. The figure of the spherical mirror is required to be excellent; both sides of the large plate may depart from flatness by several waves, but should be parallel within a few minutes of arc; the small plates do not need a good figure. There are two unsilvered reflections, so that a fairly bright light source is necessary. Either a mercury or a ribbon-filament incandescent lamp has been quite satisfactory.

"To make a Cassegrain secondary accurate to one tenth of a wavelength does not require tenth-wave flatness in the large plate. If its figure is roughly spherical, of very long radius, the astigmatism introduced by oblique reflection and transmission may be compensated in the manner already described for the normal astigmatism arising from oblique passage through a plane-parallel plate. If the figure is generally flat with residual zonal errors, such errors are readily separated from those occurring on the secondary mirror, since the former appear elliptical and the latter circular.

"In the present case, the first small plate was placed 1.5" from the pinhole and at an angle of 45° to the direction chosen as the optical axis. Elimination of astigmatism required an angle of 8.76° between the axial directions before and after reflection from the spherical mirror. A longitudinal separation of 2" between the center of curvature and the pinhole removed the slight spherical aberration. It was found that the last small plate was not required for either of these secondaries.

"In testing larger Cassegrain mirrors, some economies could be introduced. For instance, in the case just described, the test equipment is large enough to show the complete secondary. An arrangement permitting an unsymmetrical view of about two thirds of the surface would involve test pieces scarcely larger than the secondary itself."

INFORMALLY, your scribe has been told that if ½" Crystallex (Pittsburgh Plate Glass Co.) is used just as it comes, or even plate, if it is flat to a single wave and as parallel as a micrometer will reveal, the new test is better than the old one; also that the article quoted above omitted to mention that there are two returning images fairly close together and that the best looking one fortunately is the correct one to use.

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SCIENTIFIC AMERICAN

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NINETY-SEVENTH YEAR • ORSON D. MUNN, Editor

AIRLINES and air transport planes form a backbone of high-speed transportation essential to the United States in defense preparations. In time of actual emergency it would be even more important to the nation. Yet we are facing a danger, sponsored by an emotion which does not consider all the facts of the case. See article, page 53.

AUGUST • 1941

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50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of August, 1891)

PANAMA CANAL—"Parts of the canal once excavated at great cost are almost completely filled up again, and in other places the banks have washed in and the channel is obstructed. Nearer Colon, channels that once admitted vessels of 14 feet draught 14 or 15 miles inland are so blocked up in places that a canoe alone could navigate them."

UNDER-WATER—"Upon the discovery of a new Diamond Reef obstruction in the harbor of New York, it was surveyed and found to consist of a massive rock formation. It is only to-day, after twelve months' blasting, that the work of removal is on the verge of completion. The drilling scow used for executing the work is the property of the United States government. . . Through the center of the hull of the scow an octagonal well hole thirty-two feet in diameter is constructed. . . The scow really is used in a four-fold capacity, drilling, hoisting, sounding, and sand pumping. . . Within the hull of the scow is a small machine shop, a blacksmith's shop, and air compressors for the divers, while a complete electric plant is installed for lighting its interior. Experiments have been conducted also with the light under water in the diver's hands."

The drilling scow, U.S.S. General Newton.

TRANSATLANTIC—"At 2:30 in the morning, August 5, the White Star steamer Majestic arrived at Sandy Hook lightship, at the entrance of New York harbor, breaking all previous records and achieving the quickest voyage ever made across the Atlantic. She had left Queenstown in the afternoon of July 30, and completed the trip in 5 days 18 hours and 8 minutes."

CONSERVATION—"The establishment of fish hatcheries by the government, the effort to protect the seals of Behring Sea, and the reservation of the Sequoia groves are acts which give promise of a time coming when more serious thought would be given by our nation to the preservation of its heritage."

WELDING—"According to Professor Elihu Thomson, it is not the extra resistance at the break that gives rise to the heating in electric welding. The imperfect contact there no doubt hastens the heating at the joint, but the real cause of the concentration of the heating between the clamps is the relatively greater conductivity of other portions of the welding circuit. . . By keeping the conductors cool their resistance is maintained constant, and there follows an accentuation of heating effect at the joint where the rise in temperature increases the resistance."

FANS—"One of the necessities of life in Japan consists of the fan, of which there are two kinds, the folding and the non-folding fan. . . The fan is an inseparable part of the Japanese dress. A native is rarely without a fan. It is his shelter from the sun, his notebook, and his plaything. . . . The Japanese gentleman of the old school, who never wears a hat, uses his fan to shield his eyes from the sun. His head, bare from childhood, hardly needs shade, and when it does he spreads an umbrella, and with his fan he directs his servants and saves talking."

"STAFF"—"Thirty thousand tons, or two thousand carloads, of "staff" will be used in the construction of the main buildings of the Columbian Exposition. . . It is composed chiefly of powdered gypsum, the other constituents being alumina, glycerine and dextrine. These are mixed with water without heat, and cast in moulds. . . The natural color is a murky white, but other colors are produced by external washes, rather than by additional ingredients. . . . The casts are shallow, and about half an inch thick. They may be in any form—in imitation of cut stone, rock-faced stone, mouldings, or the most delicate designs."

INSULATION—"The coffer dams of cruisers 9 and 10, building at the Columbian Iron Works, Baltimore, Md., will be filled with cellulose, which has been adopted by the Navy Department. The living apartments and store rooms of the cruisers are being painted with cork paint, which consists of a heavy coat of white lead and varnish, over which is sprinkled cork. It forms a non-conducting material which keeps the ship dry in warm climates and moist atmospheres."

SIMS-EDISON TORPEDO—"The torpedo is a cigar-shaped copper cylinder about thirty feet long, adapted to carry four or five hundred pounds of a high explosive in its forward end, while about amidships it contains an electric motor and steering device, with a coil of cable to be paid out as the torpedo moves, and keeping it in constant connection with the shore. . . It is evident from trials that the Sims-Edison torpedo is a highly valuable adjunct for harbor defense and also for naval operations in general."

LIGHT—"Professor J. J. Thomson has prepared a number of vacuum tubes in which there are no electrodes, but which are surrounded by coils of insulated conductors connected with batteries of Leyden jars. These tubes contain a little gas, of sorts, remaining after they had been exhausted in the ordinary way, and every time the jars are discharged through the surrounding conductors, the insides of the tubes are filled with light, which varies in color with the kind of gas contained therein."

WHEN LIGHTNING HITS A MOTOR CAR

THAT modern steel automobile bodies are effective shields against lightning was recently proved in the laboratories of the Westinghouse Electric and Manufacturing Company, where a 3,000,000-volt stroke of man-made lightning was directed against the top of a car. Although the bolt hit the car top within a few inches of the head of an engineer seated within, the only traces of damage were small burn marks on the metal top. The circuit was completed by the charge jumping around one of the tires to ground.

KEEP OUR TRANSPORT PLANES

Scheduled Airlines are Essential to National Defense

A. D. RATHBONE, IV

SCHEDULED air transport lines in the United States are playing an important and readily demonstrated role in our national defense program as it exists under present conditions; how much more important their part would be under actual war-time conditions is a picture that can be sketched from data now available as a result of lessons learned in the European theaters of war.

Based on a study of passenger loads and express cargo carried by planes of his company during recent months, an official of one of our major airlines estimates that 60 percent of the passenger traffic today is traveling on some form of defense activity, that fully half of the express shipments transported by the line he represents are related in some way to defense work. Comparable percentages on the other United States airlines indicate that air transportation is furnishing a highly desirable means of speeding up our defense efforts. Add to that the fact that Army and Navy officials have requested that all possible important defense items be moved via the scheduled airlines, and a comprehensive picture begins to shape up.

Due to increased demands for air transportation, passenger travel on the scheduled airlines increased 65.4 percent for the year ending December 31, 1940. For the first six months of that year, the planes carried 492,145 more passengers than in the same period of 1939, and flew 11,838,732 more miles. In view of these increases in the nation's requirements for fast plane service, it is estimated that in 1941 our fleet of domestic airliners will be called upon to transport 1,500,000 more ton-miles of air express, 3,750,000 more ton-miles of air-mail, and thousands more passengers than in 1940 in order to keep pace with the stepped-up tempo of the national defense program. As the web of this defense production expands and affects every city and hamlet in the land, as the cry for speed, speed, and more speed crescendos during the present emergency, the demands on the scheduled airlines will increase rather than diminish.

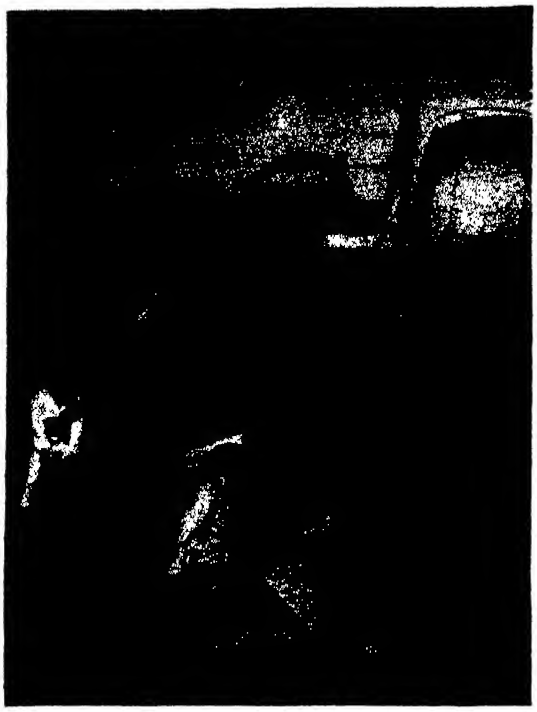
NATIONAL DEFENSE

• The air transport system of the United States must be kept intact. Our transport planes must be retained in this country where they are doing outstanding work in speeding national defense and aid to Britain, and where they would be of incalculable value to us in case of war. To these statements Scientific American subscribes whole-heartedly. Even though, as the accompanying article points out, Britain would like to acquire a large part of our commercial planes, analysis of the problem indicates that to grant such a request would be as much a dis-service to Britain as to our own country. To take these planes from their present work would be as foolish as to tear up our railroad rails to furnish steel to our British friends. Here is no question of refusing aid to a troubled nation, but rather one of preserving the facilities with which we can give them the greatest possible assistance. *The Editor* •

And yet, despite these facts, it was recently reported that, in answer to England's insistent requisitions, 20 of our passenger transport planes—almost priceless in the face of present manufacturing emphasis on military airplanes and the consequent reduced production of passenger ships—have been transferred to the British for use as aerial troop transports. Furthermore, public announcement has been made of the British request for as many as 200 of our fleet of passenger planes, and privately it has been rumored that England would like to have the entire fleet.

THERE is no question here of refusing aid to embattled Britain. Rather, it is a problem of how we can continue to accelerate our production pace of war material in order to comply with England's and our own defense requirements—if we deny ourselves the only means available for rapid transportation of technicians, scientists, workers, executives, blue prints, specifications, vital tools, parts, and so on, to and from our national defense centers and our territorial outposts. And the solution to that problem gives no thought to the part our scheduled airlines might be called upon to play in actual protection of the United States should a war-time necessity make M-Day plans a reality over-night. It has been stated on good authority that approximately 350 passenger transport planes operated by the 18 scheduled airline companies in the United States—the only air transport fleet of this size in the world, outside of Germany, capable of potentially important military use—comprise the nucleus of an emergency aviation program under the Army's M-Day plans.

Despite the aerial movement of German soldiery in the Norway campaign of over a year ago, it apparently took the recent Nazi air-borne invasion of Crete and



The emergency has increased air tonnage

the aerial transportation of German troops and supplies to northern Africa to bring into sharp focus British consideration of the need for large planes, capable of mass transportation of troops and munitions. As a spur to this evident awakening, it has been claimed that in all movements of German army forces by air, there has been utilized a total of not over 400 transport ships. With these two factors in mind, it is not surprising that England should look longingly at our highly developed flying services, for nowhere in the world is there another comparable fleet of transport type airplanes save those now occupied 24 hours a day in maintaining our established passenger, airmail, and air-express services.

However badly our big flying ships may be needed elsewhere, their removal now from our scheduled services would, in the light of existing demands for expanded flying operations, seriously cripple defense preparation facilities and tend toward reversion to the slower pace of such activities as they existed in 1917 and 1918. A comparison between potential possibilities for enhancing speed of preparedness in those times and today leaves no room for doubt as to the value of our airline system.

With memories of difficulties attendant on troop and munition movements during World War I still vivid in many minds, contemplation of the present co-ordinated networks of expanded and improved rail, highway, water, and air transportation and the respective efforts of these utilities to provide all-out co-operation in this emergency should be gratifying. The accompanying map, showing regular routes of our scheduled airlines, for example, clearly depicts the possibilities of speedy communication between the nation's most important centers of defense production and between primary plants and factories and their subsidiaries, all of which must be continuously inspected and controlled by technical experts and executives entrusted with key positions in the present emergency.

Officials of defense industries are called to Washington for vital spur-of-the-moment conferences, the decisions from which must be immediately explained and described to meetings of draftsmen, engineers, superintendents. Government mediators in labor difficulties receive instructions at the nation's capitol and, by plane, can be on the Pacific Coast the following morning in their efforts to save loss of time and stoppage of production. Recently, the supply of aluminum in a Los Angeles manufacturing plant engaged in defense work ran dangerously low, threatening a cessation of activities. A shipment was on the way, but might not reach the factory in time. Two of our large airliners were stripped of seats, flown to Pittsburgh, received capacity loads of aluminum, and transported the metal to the plant in time to prevent a shutdown. Such incidents are typical of our needs for uncurtailed and speedy air transport in these days.

REGARDLESS of these facts, misconception has arisen in some quarters concerning the number of planes actually in use over these routes. The contention has been made that certain of these lines are dispensable, that more ships than are actually needed are operating between such major points as New York and Washington, New York and Chicago, New York and California. Proponents of this argument maintain that "surplus" transport planes may be removed from some routes and sent to Britain's aid without seriously disrupting either our rapid transit flying system of freight, mail, and passengers, or the M-Day plans for civil aviation. It is not, however, alone the number of ships flying between New York and Washington, for example, that enables the airlines to hold a schedule of 49 flights daily. It is the constant use of only a fraction of that number of planes—some of which are constantly off-duty for complete maintenance and safety check-up—operating on a round-trip basis under different crews, and each averaging 1000 miles every day, that makes this service possible. Passenger and freight records show that even this frequent schedule is heavily taxed many times. That similar conditions exist elsewhere throughout the country is borne out by the defense freight and passenger figures quoted earlier.

WHEN the all-out defense program was declared in effect, there were approximately 110 commercial passenger ships of all kinds on order in the airplane factories. Immediate demands for war

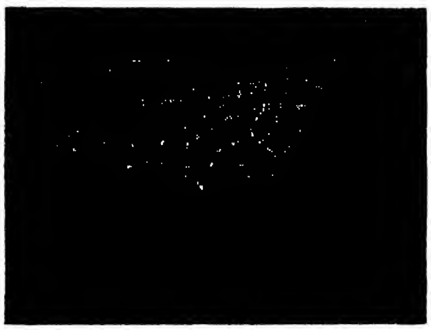
Constant check-ups for maximum safety

A Stratoliner, typifying American leadership in scheduled commercial airlines

planes relegated this construction program into the dim back-ground to such an extent that production for 1941 is estimated at not more than 50 commercial ships, barely enough for replacement of obsolete and worn-out models, and a minimum of expansion of service in normal times. With requirements for scheduled airway use increasing 65 percent last year over 1939, and an additional 40 percent increase thus far in 1941, it can readily be seen that further emasculation of our present scheduled airline facilities would place us in an unenviable position so far as national rapid transit in our defense program is concerned, and in a positively dangerous position should our air-transport system be needed for actual defense of our country.

At the very second that this is being read, according to data from the Civil Aeronautics Authority, and during every other second of each 24 hours, 225 common-carrier transport planes under the United States flag have on board more than 1500 passengers and 18 tons of this country's mail and express. It is, therefore, easy to see what a two-thirds reduction of our air-carrying power would do to an American sky service which, to most of us, has become as common as breakfast. As to replacement of the 200 transport ships which have been asked for by England, it would, as already noted, require nearly four years under the 1941 production pace assigned to this type of ship.

And what about defense of the United States, should such action ever be necessary, and if we should now grant a majority of our airliners to Britain? While the intimate and extensive ramifications of the M-Day plans are not publicly known, it is safe to assume that each of our 350 airliners has been carefully evaluated as to maximum cruising range, troop or munitions capacity, flying speed, and other factors. The 1857 airports of the United States, graded 1st, 2nd, 3rd, and 4th class by the Civil Aeronautics Authority, have come in for close scrutiny, as have all physical properties of our scheduled airways system.



America's web of airlines: vital links in our defense plans

To a man—or a woman—every member of the extensive personnel of the airlines is a trained specialist. The pilots, in view of their intensive training and broad experience, would prove invaluable as members of our military flying forces. American aviation mechanics cannot be surpassed. In 1940, for every 21 passengers on domestic planes there were in aeronautical service two pilots, one steward or stewardess, and 40 persons engaged in various kinds of ground work.

The potential strength and value of these flying assets in time of an all-out emergency can hardly be over-estimated. Our transport planes are essential to high-speed production of materials of war—both for the help of England in present-day fighting, and for this country in building up its defenses. It would indeed be a grave error to transfer two-thirds or more of our largest airplanes to a courageously fighting ally whose needs cannot be minimized, but who must appreciate that her own—and our—ends will best be served by leaving these same ships right where they are today.

As has been hinted, the airlines of the United States, valuable as

they are under conditions of defense preparations, would be of even greater value to us if this country should face the crisis of actual warfare. From the giant Boeings, with a 33-passenger capacity, to the Lockheeds, which carry a load of from 14 to 16 persons, the average plane of the scheduled airlines would transport a minimum of 14 infantrymen, equipped with full packs. Therefore, approximately 5000 troops could be speedily moved by the entire air fleet in a few hours from one part of the country to another. As for mobilization of the planes themselves for any such purpose, the exact location of every ship is known every minute of the day or night, and it is estimated that a "calling all planes" order would bring all 350 of them to any given series of fields within a few hours.

In the event heavy troop concentrations were deemed advisable, the ensuing shuttling process would provide our military forces with a mobility impossible through use of any other form of transportation. Such rapid flexibility of movement of men and munitions, now recognized as one of the keys to Nazi military successes, would be utterly impossible without an adequate fleet of flying transports co-operating with the land, sea, and air forces of this country.

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Just prior to going to press, newspapers reported a new Federal government levy on the airlines of 24 more large transports for transfer to England by August 1. We believe this must be stopped. Furthermore, it is unnecessary. On authoritative reports, there are in this country more than 100 Lockheed-Hudson bombers — ordered for England — now complete and awaiting delivery. Exact prototypes of the Lockheed Lodestar transport plane, these could be quickly converted into troop transports at small cost, thereby reserving our own airliners for the vital part they must play in our own defense.—The Editor.

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Will Bacteria Be Used In War?

Insurmountable Difficulties Stand in the Way of Employing Disease-Causing Organisms

J. J. KERSHAW

Bacterial warfare is the substance of the most recent tale of frightfulness that is being syndicated in the flaming sheets of the Sunday press from coast to coast. According to the diabolical schemes outlined, not only hostile armies but also the entire enemy population will be infected with bacilli in order to produce decimating epidemics at the front as well as behind the lines. Thus, annihilation of the enemy of the future by wholesale extermination will supposedly proceed much more rapidly and far more effectively than by other contemporary mechanical and chemical means. Presumably, bacterial warfare is to surpass chemical warfare in frightfulness; it seems that the engineer, and the chemist, and the biologist, too, will be given their chance to mobilize their secret bag of tricks containing disease breeders and organic poisons as weapons of attack. The horrors of medieval warfare are supposedly to be resurrected!

In ancient times the furies of war scourges accompanied Mars into the field of battle. Epidemics decimated the ranks far more thoroughly than the most terrible enemy. Whole armies were wiped out by contagious diseases. In the course of time, however, medical treatment and sanitation succeeded in harnessing epidemics. While during the wars of the 18th Century losses from diseases were nearly six times those caused by actual combat, this ratio dropped, in 1850, with the French troops during the Crimean War, to 3.2 to 1, and during the Franco-Prussian War, on the German side, to 1 to 0.6. During World War I the horrors of epidemics were practically eliminated, and it was only toward the end of that struggle that communicable diseases began to come to the forefront.

And now it is reported that military scourges are to be artificially loosed, that science is to be enlisted in converting these communicable diseases into effective weapons of warfare. That this question may be considered of especial importance is obvious from the fact that the use of disease organisms as an instrument of warfare was considered by the Conference on the Limitation of Armaments, held in Washington in 1922. An international commission, appointed at that time, reported as follows: 1. The effect of bacterial injury cannot be limited or localized. 2. Modern water purification methods protect against the organisms of typhoid and cholera. 3. Plague is a disease that would be as dangerous for the force using the organisms, as for those attacked. 4. The danger from typhus has been exaggerated. 5. Modern sanitary methods are effective in controlling communicable diseases.

Then the question of bacterial warfare suffered a lapse of interest, but during the past few years there has been a marked revival of interest in this supposed bugbear of bacterial warfare. Possibly this is only part of the effort of professional pacifists to add all the imaginary frightfulness they can picture to the known and very real horrors of war.

The space and thought that have been given by feature writers have not been without effect, and many people now believe that bacterial warfare represents a real threat and problem for future generations.

War history through the ages clearly demonstrates that the moral aspect has nothing whatever to do with the acceptance of implements of warfare, and it would, therefore, be useless to preach morals. In the same manner as "outlawing of future wars" will not assure universal peace, disarmament conferences and national alliances will be unable to regulate future warfare, regardless of alleged brutality or of "being against the laws of Nature." After all, it is not sentiment but effectiveness alone that decides the application of new implements of warfare. The history of war weapons has taught us that the employment of a new, appar-

ently inhuman weapon, or of a very cruel implement of warfare, will be abandoned only when this weapon, through the development of combative or protective weapons, has lost its importance or has been rendered useless by the development of a more effective weapon.

WHEN in prehistoric times a certain warrior conceived the idea of employing a sling-shot instead of "*natural* weapons," such as his fists, claws, or teeth, and tossed a stone at his opponent, he loosened a storm of protest from his enemies. The use of stones in honest combat was then considered inhuman, brutal, cowardly. Nevertheless, the next time his opponent, too, did not hesitate to employ this "cowardly" method of fighting and to throw stones; presumably he picked the most jagged rocks he could find!

The same thing happened during the subsequent evolution of the sword, the lance, black powder, the firing-pin rifle, the machine-gun, the U-boat, explosive bombs, and chemical warfare. Every time somebody tried new and "inhuman" instruments of annihilation, the disgusted adversary, "forced into it," improved upon and intensified the despicable method of fighting.

The same will probably happen with biologic warfare. If ways and means are found to decimate the enemy's ranks by communicable diseases or by deadly poisons, carried into the enemy's territory, this "cruel" and "inhuman" method of fighting will be generally adopted, despite all sentimental objections. The mere fact that the eminent peace workers at the Disarmament Conference in 1923 at Geneva considered bacterial warfare seriously enough to prohibit its use, along with chemical and incendiary warfare, justifies us in considering this agency. Fortunately for the human race, the situation is such that exaggerated fears of the devastating effects of bacterial warfare are without foundation, unless an author's imagination should become a reality, and some sort of superbacillus could be cultivated. The poor prospects of successful biologic warfare may best be judged from a few typical examples.

Let us consider, first of all, the group of communicable diseases such as cholera, typhoid, and dysentery, that attack humans by way of the alimentary canal. Formerly, these diseases appeared as epidemics in time of war and peace, though nowadays typhoid and dysentery are rare and limited to narrowly confined areas; there is probably hardly an American physician who has seen, much less treated, a cholera case. But the bacilli for these diseases may be artificially cultivated, and cases may be visualized where water and foodstuffs have been contaminated with these disease germs. But would this really bring about an epidemic? By no means, for it would be suppressed at once; the remedy is quite simple. Aristotle already knew it, and gave his friend, Alexander the Great, the good advice to "boil his water and bury his dung." In those days precautionary measures were considered effeminate and ridiculous; nowadays sewer and water systems protect us from the dangers of contamination. In a civilized country, epidemics such as cholera, dysentery, and typhoid, even if artificially propagated, may be eradicated at the source.

A second group of maladies that could be serious enough to prove effective as a war weapon, provided ways of using them properly could be devised, are the communicable respiratory diseases, such as influenza, pneumonia, and the common cold. Although the latter is no real disease, it might nevertheless produce great numbers of non-effectives. It is not improbable that infected dust might be strewn by airplanes and thus find its way into the respiratory organs. But what would be accomplished by that? Practically nothing, for we do not normally inhale air that is free from bacilli, and during an epidemic of "la grippe" not *all* people become infected. Consequently, the bacilli alone do not cause an epidemic; certain secondary factors make human beings susceptible to infection. These supplementary factors so far are little known, and as long as the actual causes of epidemics are unknown, no epidemic can be artificially generated.

THE most dreaded diseases of past wars, the bubonic plague and the typhus epidemic, which even during the World War I infested particularly the Russian ranks, are transmitted by insect bites, infected fleas, and body lice. Of course, one could imagine recently innoculated rats being dropped in cages by means of parachutes from enemy airplanes. The cages open, and the rats crawl into basements and loft buildings, the infected fleas jump about, bite humans, and, within a short time the bubonic plague is rampant throughout the land. But even in this case the devil is not so black as painted. During an epidemic of "Black Death" in the Punjab in 1924, which killed hundreds of thousands of Indians, barely six white persons died among the British troops and other Europeans within the infected area. Somehow the plague seems to halt before civilized peoples; cleanliness is the best protection.

In order to produce a typhus epidemic, lice would have to be implanted within the clothing. That this trick could be accomplished successfully may not be expected of even the most resourceful spies. Moreover, there are now means of destroying lice in a very simple manner, and louse infestation is, therefore, not to be feared in modern warfare. Consequently, epidemics of typhoid, too, are eliminated from the possibilities of bacterial warfare.

VERY dangerous organisms, on the other hand, which might be mobilized for bacterial warfare, are the spore-forming invaders of tetanus, of gas gangrene, and of anthrax. All of these agents have been mentioned as possible war weapons. It is well known that wounds infected with these bacilli cause much terrible suffering, even for the slightly wounded. But, fortunately, even this system would remain an experiment with unsuitable means. In the first place, the diseases are not communicable. In the second place, shells would have to be used as carriers of the infective agents, and these are, as is well known, naturally disinfected; no living organism can withstand the temperature generated by an exploding shell.

Last, but not least, the warfare biologists mention the possible use of toxic products derived from bacteria. The toxin of the bacillus botulinus is so powerful that instances have been recorded where .005 milligram would kill a small guinea pig. For a human being, one half milligram is equally deadly, whether consumed with food, injected into tissue, or even dropped upon the mucous membrane or conjunctiva. And a spoonful would be enough to poison the whole population of a large city. A single airplane could carry enough botulinus toxin to destroy the world's

entire population. But, although these figures are mathematically correct, it is not so simple in practice. While it would not be difficult to produce the necessary amount of botulin and to transport it, the real problem involved is how it should be administered.

THERE were over 100 billion bullets manufactured during World War 1, enough to kill the entire population 50 times; but a few of us are still alive. So it is with botulin. The disease symptoms, caused by botulin, are similar to those of typhus and of cholera, and the means of defense are similar, too. As little as we have to fear from an artificial cholera epidemic in future warfare, we need not be unduly alarmed about secret botulin poisoning at the enemy's hand. Bacterial toxins are readily destroyed by the simple expedient of heating. Therefore, like bacteria, they are unsuited for transmission in shells.

Even this brief résumé shows that biologic or bacterial warfare is a phantom of the future which, while it may scare some timid souls, cannot equal in effectiveness the implements of destruction already known. After all, human beings come in daily contact with innumerable bacilli, and there is no reason to believe that they could do much more injury to civilized peoples in time of war. Admittedly, bacterial warefare would probably cause difficulties, but it would be easier to deal with than chemical gas warfare.

The important factor in the development of implements of warfare has been, and still is, effectiveness. It is, therefore, apparent that the question of whether bacterial warfare will be used or not, will depend very largely on practicability rather than on the sentimental reactions of pacifists.

Certainly, at the present time, seemingly insurmountable technical difficulties prevent the use of biologic agents as effective weapons of warfare.

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MEDIUM TANK

Weighs 28 Tons; Speed 25 Miles Per Hour

GENERAL specifications of the Army's M-3 Medium Tank were recently revealed by Lt.-Col. H. W. Rehm, commanding officer, Detroit Ordnance Plant. This tank is being produced at the new Chrysler-operated tank arsenal and is also being built by the Baldwin Locomotive Co.

Weighing about 28 tons, powered by a 400-horsepower Wright radial aircooled engine, the M-3 has a maximum speed of 25 miles per hour, Col. Rehm stated. Its dimensions are approximately 9 feet high, 9 feet wide, and 22 feet long. The turret and certain of the front-end parts, he said, are of cast steel weighing a total of about 6½ tons, and another 6½ tons of rolled armor plate is distributed according to the vulnerability of various locations. A single filling of the gasoline tank takes 175 gallons, which gives a cruising radius of about 350 miles at approximately two miles per gallon. The armament, Col. Rehm revealed, consists of one 75-mm gun having a 30-degree traverse and a 45-degree elevation; one 37-mm gun with a 60-degree elevation; three 30-caliber machine guns; one 30-caliber machine gun with an elevation of 65 degrees, and several light hand machine guns. The crew, he said, consists of seven men, six of whom are seated while the loader of the 75-mm gun must stand while at work.

The M-3 is a rear-engine job with disk clutches immediately ahead of the power-plant, and in front of them a synchromesh five-speed forward and one-speed reverse transmission. The drive is through the front end where the Cletac method of steering is provided. In this steering method the power is always applied to both tracks, but the inner track may be slowed to one-sixth of the speed of the outer track. In describing the tracks, Col. Rehm said that they are made up of 79 shoes, with rubber covering on the contacting surfaces, and are hinged together with rubber bushings so that there is no metal-to-metal contact. They are guaranteed for 2000 miles and last considerably longer, he stated. The bogie wheels and idler at the rear are also rubber tired, so that the only steel contact is with the driving sprocket at the front.

Col. Rehm noted that the armor plate is the latest design which does not shatter when punctured by a projectile. The only danger to the crew, he said, would be from the projectile itself or the slug of armor plate pierced out, rather than from the splinters of armor which are present when normal armor plate is punctured.—*S. A. E. Journal.*

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UTILITY: A tank moves over seven times as far per dollar as a cavalry unit and can hurl from five to seven times as many pounds of bullets at the enemy per man employed—Army Ordnance, May-June 1941, page 604.

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BOMBPROOF

Concrete Roof on Aircraft Plant

ENGINEERS for the $21,000,000 Ford Motor Co.'s aircraft engine plant, now under construction at Dearborn, Michigan, have provided a bombproof roof of reinforced concrete to protect the vital first floor from air attack damage, reports *Engineering News-Record.*

Overhead protection will be 22 inches of reinforced concrete, while service tunnels carrying electrical conduits--"lifelines" of the plant—will be buried underground beneath a 12-inch layer of steel and concrete.

It is understood that studies made in England show that bombs now in use cannot penetrate such protection. Ford engineers estimate that the first floor should be secure against critical damage from any but the most prolonged air attack.

Reversed "Blackout"

Glaring Lights May Be Effective Protection

A CANOPY of glaring light over a city in danger of invasion would afford better protection than a blackout, in the opinion of A. F. Dickerson, head of General Electric's illuminating laboratory.

This canopy, created by a huge battery of small but powerful searchlights pointed upward from the tops of buildings, would tend to prevent enemy flyers from locating vulnerable targets.

An added advantage of the canopy of light would be that enemy bombers, silhouetted against it, would become easier prey to defending fighter planes flying at higher altitudes. The lights would also assist anti-aircraft defense.

When Bores Must Be Hardened

Electro-Magnetic Induction Process Provides a Means of Improving Wearing Surfaces

A. P. PECK

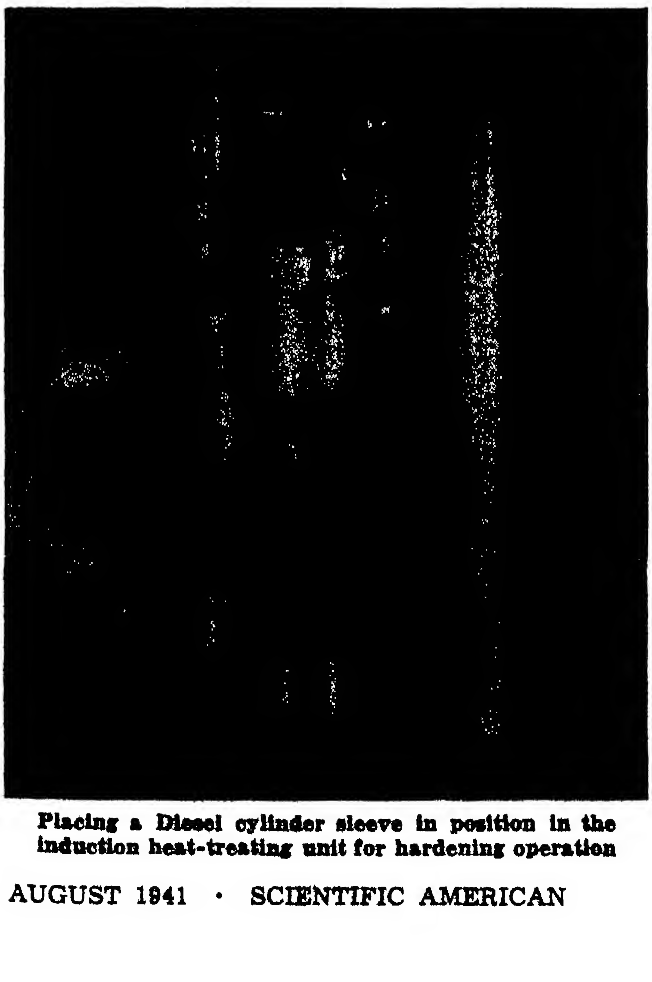
AN ELECTRO-MAGNETIC heat-treatment process which holds promise of creating improvements in nearly every ferrous product containing bores which must withstand wear or stress has already been developed into a practical production-line unit. It has long been recognized that if the bore of a cylindrical object could be hardened while the remainder of the part was held in an undisturbed condition, the entire manufacturing operation could be simplified. Existing methods of hardening, however, did not meet design and production requirements, until the induction method of heat treatment was developed by Budd Induction Heating, Inc.

The objective of the development of this system was to achieve the improved physical characteristics which would naturally result from the production of a hard bore on the interior surface of a cylinder without disturbing the metallurgical condition of the remainder of the unit. It was also hoped that a wider range of metals, including alloyed as well as non-alloyed ferrous metals, could be satisfactorily surface-hardened under production conditions. All of these desirable features have been realized and, furthermore, are being achieved in coördination with a control system which operates automatically. Thus is assured uniformity of hardness throughout the treated area, uniformity of area treated, and uniform depth throughout the area which has been hardened.

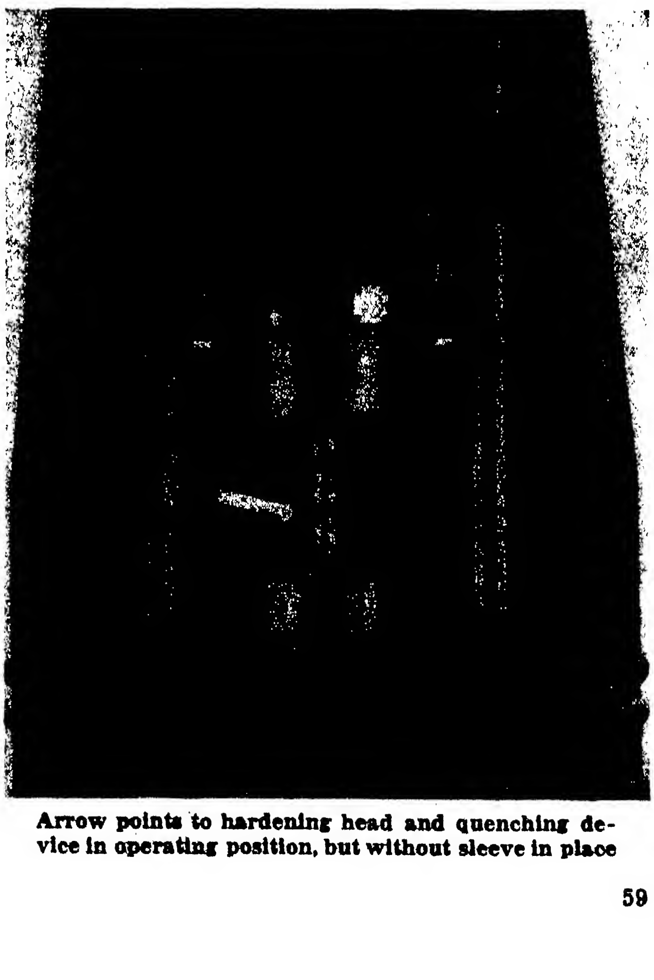
Already applications of the new process are engaging the attention of engineering departments in widely divergent fields. It is stated that aircraft engine designers are experimenting with the method and that machines for the heat treatment of oil-well casings, to increase overall strength, are now under construction.

The outstanding application of this heat-treating method, and the one which shows most graphically its implications and possibilities is that which is now producing cylinder liners used in the Diesel engines of the Caterpillar tractor line. This is regarded as the first 100-percent production application of electro-magnetic heat treatment to the cylinder bores of internal combustion engines. The treatment produces an interior bore surface of controlled hardness, resulting in a longer-wearing sleeve with markedly improved physical properties.

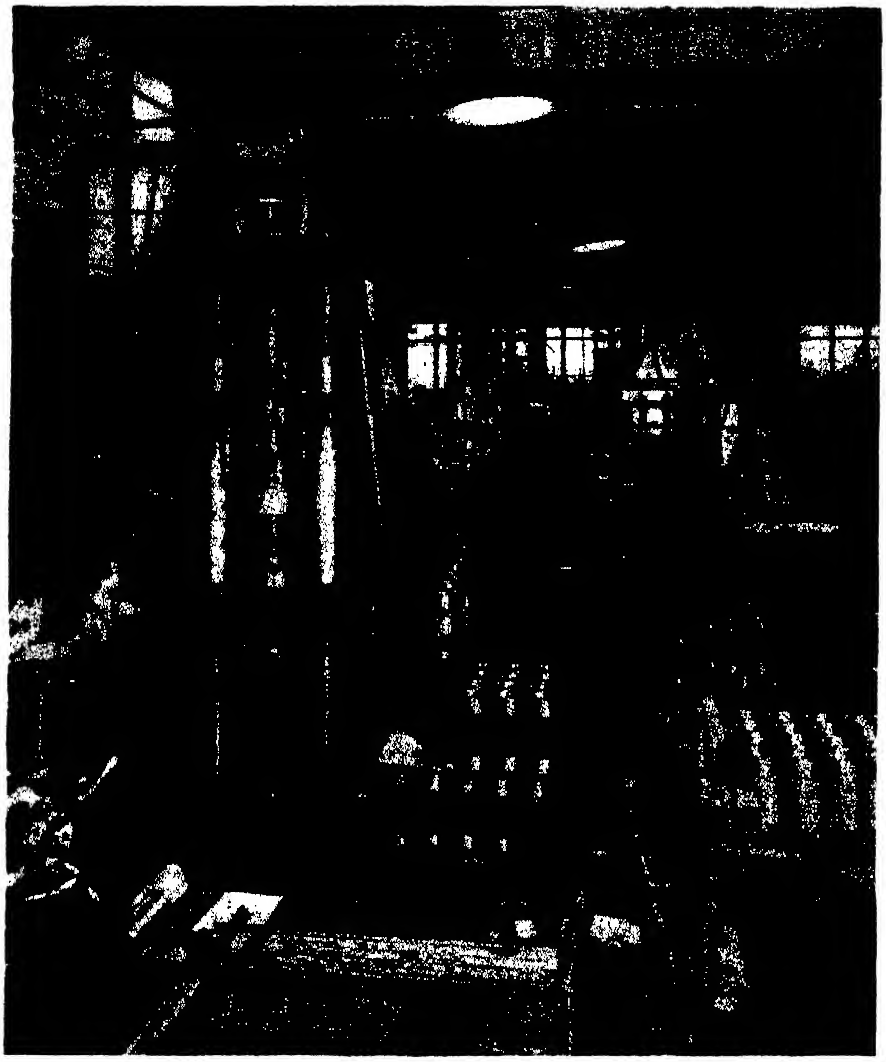
IN THIS installation, to which has been applied the name "Hi-Electro," the heat-treating machine hardens the inside diameters of the cast-iron liners to a surface hardness of Rockwell "C" 52-55, which is subsequently tempered to a slightly lower hardness. Depth of the hardened area developed is approximately .070 of an inch. Liners from 10 to 15 inches in length, with bores varying from 3¾ to



Placing a Diesel cylinder sleeve in position in the induction heat-treating unit for hardening operation



Arrow points to hardening head and quenching device in operating position, but without sleeve in place



Heat-treating machine (left center) for electro-magnetic hardening of Diesel-engine cylinder liners is located directly in production line

$5\frac{3}{4}$ inches in inside diameter, for different sizes of Diesel engines, are in production. Following the operation of hardening and tempering, the bores are honed to the final finish, after which the liners are finish-turned for insertion into the cylinder blocks.

The finished sleeve is reported to be superior in physical characteristics and wear-resistance to any which have been previously produced. While the bores are extremely hard, providing maximum resistance to wear, the sleeves are not brittle, and quality and uniformity of product are maintained at high standards.

An interesting feature of this method of heat treatment is the fact that the hardening operation serves as an additional check on previous inspections of the units treated; the treatment emphasizes any porosity or imperfections which may have escaped visual and surface examinations.

Differential hardening by electro-magnetic induction is accomplished through the concentration of high-power, high-frequency currents in the surface zone to be hardened. As applied in the new method of hardening the inside diameters of cylindrical objects, such as cylinder liners, the currents are caused to flow almost entirely in the shallow internal surface zone to be heated and to be so concentrated that the temperature of the zone affected is raised to hardening temperature before any substantial amount of heat can drift to the remainder of the piece.

In this way, the required heat is almost instantaneously generated in the zone to be hardened. This thermal energy is then "trapped" through the immediate application of a controlled water quench. An extremely hard surface is thus obtained, while the remainder of the cylinder, due to the speed of the operation, has remained relatively cool and has therefore not been affected from the viewpoint of hardening.

As the power input and timing of the current application, and the volume, pressure, and angle of direction of the quench are accurately controlled, it follows that the hardness developed, depth of the hardened area, and the area treated are also controlled within exceedingly close limits. The time required for the entire heating and quenching operation is a matter of but a few seconds.

The first successful application of the process was to the bore of automobile hubs. in which a section of the interior surface was hardened to form a roller bearing race. More than 4,000,000 of these units have been turned out for a major automotive manufacturer without a failure being reported.

Composite heat treatment is also possible with the new process. A tube which has been heat treated throughout may, as one engineer has expressed it, be "kissed" on its interior surface by the heat-treating head to produce a still harder face, thus improving wear-resistance of the bore, while retaining high physical characteristics.

High speed of production is another advantage. In the automobile hub application, for example, three to four hubs per minute are being hardened with each machine in operation. Aviation cylinders, it is claimed, can be treated at the rate of 60 to 100 per hour per machine.

The operation is accomplished through the use of a carefully engineered induction-heat head which is drawn evenly through the bore under treatment; conversely, the part may be drawn progressively over the heat head. As this head travels through the bore, a high-frequency current is applied, setting up the magnetic lines of force which result in heating of the metal under treatment. This operation is followed immediately by the controlled water quench.

The movement of the head, application of the current, and operation of the quench are all entirely automatic, thus removing any possibility of error in the process once the machine has been set for a particular operation. It is not necessary that the source of high-frequency current be placed adjacent to the machine. The power can be successfully transmitted over considerable distances

with negligible power-line losses.

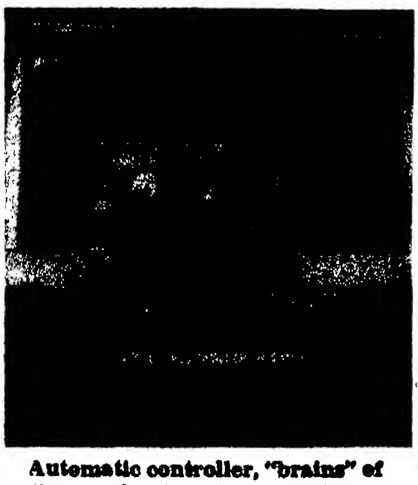
The heat-treating set-up is extremely flexible, and is carefully designed for rapid change-over from one size bore operation to another. This makes possible efficient treatment of different size units without time-consuming change-overs.

As the machine is compact enough to be placed directly in a production line (as in the Caterpillar application), the need for trucking or handling of parts between the line and heating ovens is eliminated, and only one operator is required.

The heat-treating machine is, actually, a machine-tool developed for the purpose of heat treating by induction; it reduces the process of heat treating to machine-tool precision. Thus it meets the demands of modern industry for simple operation, improvement of product, increased speed of production, and uniformity of units produced. Further, it substantially lowers production costs in many applications.

The process makes possible the production of improved units in nearly every type of machine in which cylindrical metal bores are subject to wear or stress. Hardness is produced at points of greatest wear, while a tough, ductile core is retained to provide maximum strength. Physical characteristics of the parts treated are, in effect, "tailored" to fit wear and strength requirements.

Where design of a unit permits, the outside diameter, and all other unhardened areas, can be machined after heat treatment of the inside diameter of the bore. As the depth of the hardened area is accurately controlled, the area which can be machined after the bore has been hardened can be very precisely determined.



Automatic controller, "brains" of the production-line heat-treating machine, maintains timed sequences of operation by means of precision cam switches

The Budd process permits redesign of parts with lowered weights and costs in cases where localized heat treatment may favorably alter the metallurgy of the casting or forging to the point where a predetermined internal area of the original casting or forging becomes a hardened wear-resisting surface.

In materials containing temper or uncombined carbon, recombinations of this carbon at an accelerated rate can be accomplished through this method of induction heat treatment, thus increasing the "hardenability" and strength of the area treated. The grain size of the treated material may be made consistently smaller, which is an advantage in most applications; improved physical properties can be developed in this manner.

Gross distortion, scaling, necessary straightening, decarburization, the necessity for using more stock in order to compensate for adverse distortion, and grinding checks due to lack of uniformity of structure, are no longer problems. The short cycle, in combination with the rapid quench which follows, virtually eliminates oxidation. At the same time, it has been found that annealing or normalizing treatments are less frequently required before hardening than when other methods of heat treatment are applied.

To the question, "How long a cylinder can you treat?" engineers answer, "How long a bore do you have in mind?" Lengths varying from a fraction of an inch upward can now be treated, and it requires only the adoption of known engineering principles to the design of equipment to handle lengths other than those now being processed.

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New Tin From Old Cans

Can the Tin from Our Used Tin Cans Be Salvaged—Profitably?

ALBERT G. INGALLS

A FEW months ago there was doubt whether a Pacific war would not catch this nation seriously short of tin, an almost if not entirely essential material for our civilization. Since then the tin situation has eased very considerably. Thanks to the "stock pile" of tin this nation has laid in we now have better than a year's supply of tin on hand, and it is hoped that in case of a war in the Pacific the situation could be dealt with after the lapse of that time, either by winning that war early or by a combination of using Bolivian tin and exercising economies in the use of the tin we already have. Thus the tin situation is well in hand but not necessarily solved, since wars have an inconsiderate way of lasting longer than the armchair commentators prophesy. In case, then, of a pinch, what would be our chances of recovering the large amount of tin used on tin cans, instead of throwing it away as we do at present?

This proposal has been under recent discussion in Government circles and in the tin trade and industry. The Technological Committee of the National Academy of Sciences has advised the Government that, unless and until an emergency in the supply of tin renders it imperative to conserve tin without regard to its cost, the cost of collection and recovery would be prohibitive. Others think similarly or acknowledge that the question is close to the economic borderline. Yet, despite this, tin from the used and thrown out cans of one large American city is being salvaged and at an actual profit—small, but at least a profit. Can this be just one more instance of a mere fact demonstrating the fallacy of a fine theory?

LET'S look briefly at tin, by means of a very few, rounded-off, painless statistics. (For exact statistics, see "Metal Statistics, 1941").

The world produces something like 150,000 tons of tin a year. (It's higher just now, creeping

toward 200,000 but this is abnormal.)

About two thirds of this tin comes from British Malaya, the Netherlands East Indies, and other places in the Far East.

About one sixth of it comes from Bolivia.

The United States consumes almost half of the world's output.

Something like half of this half goes into solder, bronze, babbit, collapsible tubes (toothpaste, shaving cream, and so on), tin-foil, type metal.

Photographs courtesy *Engineering News-Record*

Used tin cans separated from refuse at Hyattsville, Maryland

The other half goes into tin plate.

About 90 percent of this tin plate, accounting for about 30,000 tons of tin a year, is used to coat steel cans. Tin cans contain about 98½ percent steel and 1½ percent pure tin.

We make about 17,000,000,000 tin cans a year.

TIN is not an abundant metal on this planet. It therefore costs something like four or five times as much as copper and eight or ten times as much as lead (present price of tin, about 50 cents a pound). Our hefty American appetite for tin is so strong that it keeps sucking that metal out of the earth in the Far East and hauling it around the earth's bulge to this almost tinless country in a perpetual stream. We use it only once and then throw it away. How expert is the job of minutely dispersing the 30,000 tons of tin which we withdraw from this planet's tin bank every year is seen when it is realized how efficiently we go at it. In the first stage we ship the 17,000,000,000 cans, full of food or other content, far and wide, and in the second we send the emptied cans to refuse dumps where, after the iron in them has rusted down, the tin is left in extremely small amounts in 17,000,000,000 places. The tin still is on earth but might as well be on Pluto as far as its availability to future generations is concerned. This, however, is only a conservation argument—another comparable one being the fact that we are placing millions of tons of iron about equally out of future reach by sending it to the ocean floor. We are "conserving" it.

While some have theorized that the tin from used cans cannot be salvaged profitably, the Washington Suburban Sanitary Commission, at Hyattsville, Maryland, just outside of the District of Columbia, recently has been and still is salvaging this kind of tin and selling it at a low but clear profit—and saving the tin as well. Harry R. Hall, Chief Engineer of the Commission, states that, after deducting transportation costs, labor, power, engineering, and administrative costs, also fixed charges on installation, the Commission's collected cans, crushed and baled, have been affording a profit of $3.67 a long ton. Can other municipalities do the same? Possibly they can at present when tin is high. No doubt the profit would vanish if tin prices fell even a small amount. Even so, the Hyattsville experiment is significant.

In salvaging used tin cans there are, of course, troubles.

Training the public—the average householder—to segregate tin cans when refuse is set out for city scavengers is a real problem in human engineering—you can push machines around, but humans are harder.

Used cans crushed and baled for shipment to a de-tinning plant

The collected cans must then be crushed and baled, in order to save space in freight cars en route to one of the nation's de-tinning plants.

When the cans reach these plants they are again a problem. Ordinarily such plants work only on clean trimmings and scrap from can factories. The salvaged cans contain the faded remains of corn, beans, and tomatoes and are not as popular at the plants as sweet, clean tin trimmings.

The reagents that bring about the de-tinning of used cans don't get at all the tin, much of which remains in the seams.

The steel from the cans has a lowered sales value because it contains about one part in 1000 of tin, making it poor steel because of this tramp alloy.

What of substitutes for tin as a protection for the steel of cans? None having tin's long list of admirable qualities has forced its attention on the world thus far. Tin is possibly more nearly ideal for can covering than many have realized. It is at once: Strong. Inexpensive in the small amounts used on each can. Light. Non-toxic. Sanitary. Easy to work. Durable. Good to look at. Perhaps we get more of a psychological something out of food from a shiny, bright tin can than we realize.

It will not be hard to find substitutes for tin on cans if the necessity arises, but it will be hard to find a substitute that equals tin in all these respects.

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BETTER TOBACCO

Aromas Transferred by Chemical Means

THAT "good five-cent cigar," with color and aroma equal to a quarter perfecto, may be just around the corner, thanks to new chemical means for processing tobacco, developed at Columbia University and reported by *Science Service*.

One of the steps in the new treatment consists in the extraction of the aromatic substances from tobacco with alcohol. These substances, which give certain tobaccos their choice properties, are not affected by the treatment, and can be transferred to other tobaccos in which they are lacking. This will make possible the salvage of costly aromas from tobaccos that would otherwise have to be discarded for other reasons. It is even possible to achieve the effect of a blend by treating one kind of leaf with several kinds of aroma extracts, the Columbia experimenters reported.

Along with the aromatic sub-

stances, the resins that make certain kinds of tobacco undesirably dark also go into solution. This necessitated a second step in the process, to decolorize the extract before it is used. This is accomplished by passing the solution through a fine-pored carbon mass, on which the dark resins are adsorbed.

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CANADA FAR AHEAD: In the production of platinum metals Canada now stands far ahead of Russia, with 57 percent of the world total, while Russia has only 19 percent. South Africa is third, with 11 percent, the United States is fourth with 9 percent, and Colombia fifth with 6 percent.—Review of Scientific Instruments.

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COTTON HOUSE

A Possible Outlet for Surplus Crop

IN THE model cotton house, sponsored by the Department of Agriculture as an example of low-cost housing with special reference to defense needs, the walls are insulated with a water-repellent, fire-resistant cotton "blanket." This form of insulation, called Reyn-O-Cell, a product of the Reynolds Metal Company, is installed in the ceilings and the outside walls. More than one 500-pound bale of cotton

Cotton "blankets" for houses provide insulation, are fire-proof

goes into the house in this form; one-third of a bale of cotton is used in the flame-proof fabric covering the ceilings and the inside and outside walls of the house. The fabric is hot-pressed to fir plywood sections with a synthetic resin adhesive, providing a canvas-like surface which can be decorated in any manner desired.

It is claimed that the cotton "blanket" insulation, with space on either side for the circulation of air, will withstand extremes of climate. The air circulation aids in dissipating condensation and minimizing structural decay. In setting up the cotton house, the prefabricated ceiling, sidewall, and floor sections are tied together with a system of steel rods. Only 62 hours of labor are required for the complete erection of the house, ready for occupancy.

Wisp of wire controls carbon content of steel

CARBON GAGE

Hot Wire Controls Steel Quality

IN THE Endogas method of treating steel, developed by Westinghouse Electric and Manufacturing Company and reported some time ago in these pages, a protective gas is used in the heat-treating furnaces to prevent softening or scaling of the surface during treatment. It is necessary, however, that the protective gas be of precisely the correct composition for the work in hand.

Since the carbon content or pressure of Endogas is the critical factor, it must be carefully controlled. It is not possible, however, to make this determination quickly enough by ordinary chemical analysis; therefore there has been developed what is called a "hot wire carbon gage." In this gage a thin steel wire is heated for a few minutes in a test sample of the Endogas until a "carbon balance" is established between the gas and the wire. Because the wire retains its carbon in a solid form known as martensite, its electrical resistance and certain other physical properties can then be used as a measure of its carbon content, which in turn measures the carbon pressure of the gas. By means of this gage the quality of the furnace atmosphere can be quickly determined at any time and pre-adjusted to suit the carbon content of any steel to be treated.

PARTITION

Prefabricated, Ready for Plastering

BUILDING partitions in which all materials, with the exception of plastering supplies, are designed, fabricated, and shipped knocked-down as a complete unit, is the latest development of the Reynolds Metals Company. The new product, named Reyn-O-Wall, is a lightweight partition system, two inches thick, for use in the construction of non-load-bearing walls, and is made of two layers of steel-reinforcement securely attached to each other, leaving an air space or hollow core between the layers. The core is reinforced on both sides with vertical galvanized steel V-shaped ribs.

Simplified erection is claimed as an outstanding advantage of this new type partition wall. The prefabricated core sheets are self-supporting, requiring no studs, and are erected in units extending in one piece from floor to ceiling. U-shaped anchor clips of galvanized wire are supplied for firmly securing adjacent core sheets together. The resulting wall is lighter in weight than ordinary partitions, and the hollow core provides high sound-deadening value, eliminating the drum-type noises frequently experienced with solid

core partitions. As it is fire-resistant as well as sound deadening, and saves floor space, it is especially suitable for use in apartment houses, hotels, office buildings, post offices, schools, hospitals, and the like; because of its low initial installed cost, it is recommended for use in low-cost housing projects.

The partition provides substantial savings in plaster materials. Mortar thickness, uniformly maintained over the entire partition surface, prevents the tendency toward map cracking frequently caused in old-style construction by abrupt changes of mortar volume when applied to partition surfaces of the conventional type.

Door frames, electric light outlets and conduits, pipe lines, and so on, are set in place prior to erection of the system of partitions. A metal box-type base and perforated ceiling runners, together with accessories, are supplied. The base is installed directly upon finished concrete or wood floors, and the runners are tied or nailed to the ceiling, depending on the construction. The core sheets are then set in the slots in the base and attached to the vertical leg of the ceiling runner. They are securely fastened in place with annealed steel tie wires. The partition is then ready to receive a uniform thickness of plaster.

COOL GLOVES

Air Currents Protect Worker's Hands

In many industrial processes it is necessary for workers to handle hot materials and finished products, and in some cases even the protection of asbestos gloves is not sufficient; heat will strike through the gloves and produce scorch burns.

In one manufacturing process—the production of sealed-beam headlights in the Westinghouse Electric and Manufacturing Company's Lamp Division—employees have to lift highly heated units as they emerge from an oven. In order to produce more comfort for these workers, "air conditioned" gloves have been introduced. A low-pressure air hose is extended into the gauntlet of each glove to provide a circulation of cool air which eliminates possible burns. A surprise effect of the use of these air-conditioned gloves was that it

Prevents scorched hands

also made possible a better product. There is less shrinkage in the lamp glass because, with the worker using air-conditioned gloves, it became possible to make a change in the pre-heat temperature.

RUN-IN

Engines "Broken-In" Electrically

What is believed to be the industry's only battery of electrical run-in stands for light-plane engines is used by the Lycoming Division of the Aviation Manufacturing Corporation for the "break-in" run of 65 and 75-horsepower Lycoming engines.

Tests have proved that this "cold" run-in for a period of six hours, followed by operation at full rated speed under the engine's own power, produces better results

For Information on New Products and Processes, See the Section

Industrial Growth

Page 88

than when the engine is operated on the test stand entirely under its own power.

Before beginning its electrical run-in, each new engine is completely assembled, including all accessories, and is equipped with an oil filter to pick up any dirt or chips which may be in the engine. Fresh oil is then circulated through the engine while it is operated electrically at a speed of 1700 revolutions per minute. A flexible coupling drive is used between the electric motor and the engine, and a pressure switch is connected between the oil pressure line and the motor switch to cut off the motor automatically if the oil pressure drops below the normal operating point.

Electrical run-in stands test 50 airplane engines daily

DRINK IT . . . OR SIT ON IT

FROM the coffee bean of Brazil has come, for many years, a beverage that is as truly American as are chewing-gum and ice-cream. From the same bean, as a result of American ingenuity, now may be obtained furniture and wall paneling made of Caffelite, a plastic that is making a bid for its own place in the industrial sun. Nor do the possibilities end with furniture and paneling; these are reported to be the major uses to which the new plastic is to be put, but they are only part of the story.

Many months ago (October 1939) this magazine recorded the development of a plastic material made from surplus coffee, a raw material which is so plentiful in Brazil that over 800,000,000 pounds of it, on the average, have been burned annually for the past 10 years. Obviously, such waste could not go on unchecked; it offered too much of a challenge to the inquisitive minds of those men of research whose business is to find uses for everything but the squeal.

But on this page we are not so much concerned with actual processes; our aim is to seek out and report the implications of developments as they reach the industrial stage, thus laying the foundation for an estimate of future possibilities based on present-day trends. For those who want to know more of the background of coffee plastics, the reference given above will serve; for those who would evaluate coming events by an analysis of the shadow that is cast before, the following paragraphs will point the way.

It is probable that by the time these words reach the reader there will be in operation in Sao Paulo, Brazil, the first commercial plant for the conversion of coffee to plastics. According to present plans, the capacity of this plant will be 215 bags (135 pounds each) of coffee daily. From this will be produced some 18,000 pounds of Caffelite each day. Following the completion of this first plant, two more are scheduled to be placed in operation next year. These three units will provide a potential production of 500,000,000 pounds of coffee plastics and by-products per year. That this huge total quantity will be made available to markets of the world for some time to come is unlikely; estimated world consumption of all plastics is only about 750,000,000 pounds annually. But as the use of plastics continues to increase by leaps and bounds, the time is probably not far distant when a goodly portion of this potential production will be put to useful purposes.

Chief among the outstanding features of the versatile Caffelite, developed by H. S. Polin Laboratories, Inc., New York, is its low cost. Present claims, backed by substantial experimental work, are that it can be produced at well below the cost of the various plastics now in wide use; these are available in the United States at prices from 14 cents a pound and up. Just where Caffelite will fit into the price picture cannot yet be definitely stated, but the whole scene is pretty sure to be favorable toward it.

Versatility of the coffee plastic is seen in the facts that it may be used as a complete molding plastic in either thermoplastic or thermosetting types, that it may be mixed with a variety of other plastic materials to reduce final costs, that it has chemical properties similar to those of the phenolic resins.

An interesting and industrially important sidelight on the manufacture of coffee plastic is the list of by-products that are obtained in the process. This list includes oils that are useful in the production of cosmetics, lacquers, insecticides, soaps, and other materials; vitamin components of interest to the producers of medical supplies; and caffeine, used in soft drinks.

NEW TIRES FROM OLD

CONSERVATION of rubber supplies, a highly desirable measure in these days of economic uncertainty, may prove a blessing in disguise to at least one industry. Started some years ago to provide inexpensive motor-vehicle tire service for those who must count pennies, the tire retreading and recapping industry has grown steadily to a point where it recently received the blessing of the Rubber Manufacturers' Association. No longer an unwanted ugly duckling to be kept out of sight when company calls, the tire rebuilding industry is now assuming the role of an important factor in the tire world.

Leaders in the rubber industry have predicted that there will be a sharp curtailment of rubber consumption by the last half of 1942. This will mean, of course, an equally sharp reduction in the number of motor-vehicle tires produced. And since tire consumption is rising rapidly in the United States—replacement tire shipments early in 1941 were 25 percent ahead of those of the year before—it becomes obvious that any satisfactory expedient to reduce the need for large quantities of rubber will be well received.

FILM SUBSTITUTES FOR CANS

DEHYDRATED foods, declared equal in nutritive value to canned foods by the Food Committee of the Army and Navy Rations Board, may help to solve at least part of the tin question discussed on this page last month, and on page 61 of the present issue. This assistance is becoming evident by the success of dehydrated soup mixtures now being sold on a national scale, protected from moisture and contamination by an envelop of Pliofilm, product of Goodyear Tire and Rubber Company.

Although soup is not the only food being packaged in Pliofilm, it serves as a shining example of the possibilities of the process. The water content of a can of soup may be as high as 80 percent. By removing this water, and later replacing it just prior to serving, not only can the soup be delivered to the consumer without the use of a tin can, but savings are found in weight and hence in shipping, handling, and storage costs. Tests involving merely placing the contents of a soup package in water and boiling for the specified time, show that the resulting food is fully equal in gustatory satisfaction to the canned variety.

The moisture-proof properties of Pliofilm have been amply demonstrated by the use of the material in raincoats, shower curtains, tobacco pouches. Now it is protecting the soup mixtures as well as malted milk, buttermilk, molasses, and other food products in dehydrated form.

—*The Editors*

The Healing Poison

Snake Venom Stops Bleeding and May Win a Place as a Deadener of Pain

A. H. ALEXANDER

When three-year-old Donald Richardson was admitted to the hospital in Kansas City, the doctors were not too hopeful about his chances. Donald was suffering from the rare disease, purpura hemorrhagica. Like the dread hemophilia—scourge of Europe's royalty—this disease is also one of uncontrolled bleeding. Donald was bleeding internally. Blood oozed slowly from his tiny blood-vessels, and formed purple splotches on the lining of the mouth and nasal cavities. The child grew steadily weaker as the precious fluid seeped through the thin-walled capillaries. Death was inevitable unless the hemorrhages could be stopped.

Calcium, iron, gallic acid—the old classic remedies—were tried, but without success. Time was precious. Hurried consultations were held. Finally, it was decided to try snake venom. But in each doctor's mind was the question: Could a three-year-old survive the treatment? It was new, experimental, hazardous.

The parents were approached. He may not live through it, they were told—but it's the last desperate chance. With faces wept weary by weeks of anxious waiting, they gave their consent.

In a nearby biological laboratory a white-robed assistant gingerly lifted a four-foot moccasin from its cage. Its thick, dark body squirmed vigorously in an effort to escape, but firm fingers held the reptile. A cone-shaped beaker stood nearby, with a thin membrane stretched across the top. The technician brought the snake's head near the beaker, and with a deft manipulation the jaws were forced open. The long, needle-like fangs sprang into view. Quickly the operator forced them through the membrane, and at the same time his experienced fingers found the snake's poison sacs and pressed them gently. There was a spurt of venom as the fangs pierced the membrane. With experienced fingers the assistant massaged the poison glands in order to obtain a maximum yield. The viscous, yellow fluid dropped slowly from the tapered fangs. When the last drop had been gained, the snake was carefully put back in its glass box.

The venom was rushed to the hospital. Would it save the child's life; a life that had scarcely begun?

For several years scientists had been experimenting with moccasin venom as a coagulent. There had been some success—nothing spectacular — but evidence which showed that it hastened clotting and to some extent strengthened blood-vessels. On the basis of these results, the physicians hoped that by injecting small quantities into Donald's blood stream they could augment the natural clotting agent.

The first injection was three drops. The doctors waited. No harmful effects. After several days they repeated. Again they saw no evidence of negative results. They increased the dosage and shortened the time interval. For three weeks they continued to administer the venom. The child's resistance to the poison increased until he was able to withstand as much as 15 drops—a fatal dose for many an adult. Slowly the blood vessels grew stronger. The ugly purple blotches began to disappear. Snake venom had turned the tide. A smiling child emerged from the hospital—cured of the insidious purpura hemorrhagica.

It must be emphasized that not all the results with venom have been as dramatic and gratifying as in the case of Donald Richardson. Nevertheless, there has accumulated in the past few years a mass of experimental data to support the view that snake venom may one day have a fixed place in therapy.

References to the use of snake venom can be found in the literature of many peoples. These ancient accounts often relate marvelous cures of cancer, leprosy, epilepsy, and so on. The medical scientist of today approaches with skepticism these accounts of miraculous cures with snake venom. He realizes that many of the drugs and remedies which fill the old pharmacopoeias are vestiges of the days when black magic was considered more important than science in the cure of disease. At the same time, however, he is aware that occasionally these remedies have a basis in actuality.

Every physician knows that there is no sharp distinction between a drug and a poison. When used unwisely, many of our most beneficial drugs become poisonous. Conversely, a number of poisons—strychnine, mercury, arsenic—are

All illustrations courtesy New York Zoological Society

The water moccasin, whose powerful venom is used to stop bleeding. In some cases the poison is used in a high dilution of one part to 3000

valuable medicinals when employed carefully. The most important factor is the size of the dose; not necessarily the character of the drug itself.

Roughly speaking, there are two kinds of toxins in snake venom: one which attacks the blood cells, and another which destroys the nerves. The former is called hemolysin; the latter neurotoxin. Venom may be of one type or the other; often it combines both. Cobra venom is essentially neurotoxic in effect; the moccasin's is hemolytic. Hemolysin breaks down the blood cells. Neurotoxin, on the other hand, attacks the nerve centers and the nerve endings. This brings about a paralysis which, when it reaches the respiratory organs, results in death by asphyxiation.

The greatest success thus far with snake venom has been in the control of bleeding and in the relief of pain. It must not be assumed, however, that the last word on venom therapy has been said. On the contrary, the work is still in its infancy. Some of the conclusions of the early enthusiastic investigators have not withstood the test of re-investigation. Nevertheless much research is going on and progress is being made. But, until more definite results have been obtained, physicians will continue to be wary about making sweeping claims.

The fer-de-lance, of tropical America. Diluted to one part in 5000, its venom is applied directly to bleeding tissues, often in dental surgery

One of America's foremost researchers in the use of venom is Dr. Samuel Peck, of the Mt. Sinai Hospital, in New York City. In 1931 he and a colleague, Dr. Sabotka, discovered that they could make rabbits resistant to an acute type of focal purpura by injecting moccasin venom. With other types of skin hemorrhages they had equally encouraging results.

The blood of hemophiliacs—congenital bleeders—which normally required as long as from 20 to 45 minutes to clot, could be made to clot firmly in 17 seconds by adding a dilute solution of the venom of the Daboia snake. This snake, a native of India, is commonly called Russell's viper; its bite is extremely poisonous. Hemophiliacs rarely live to a ripe old age. When a victim of this incurable disease starts bleeding, the danger is acute. Small skin abrasions, or a minor operation, may lead to the loss of a huge quantity of blood. The mere extraction of a tooth often proves fatal. The venom of Russell's viper has helped in some cases to stop this kind of bleeding. Chronic nose bleed, as well as other types of intractable bleeding, has responded to treatment with venom.

The Russell viper, which causes more deaths in India than the cobra. Its highly toxic poison, greatly diluted, is also used to stop bleeding

At the Mayo Clinic, Doctors C. H. Watkins and G. J. Thompson tried moccasin venom for a serious kidney disorder which is accompanied by blood-stained urine. Improvement in the control of the hemorrhages was noted in all cases.

At the gynecological and obstetrical service of the Lincoln Hospital, in New York City, moccasin venom was tried on 100 expectant mothers. The problem was to study its effect on bleeding at childbirth. The women were divided into two equal groups. One group was given venom injections previous to delivery; the other was not. Subsequent results showed that the period of bleeding was definitely shortened for the injected group. The amount of blood lost was also materially decreased. An analysis of the blood in the cords of the new-born infants indicated that no venom had entered into the circulation of the child. Neither mother nor child suffered harmful effects. It was suggested that the use of venom in childbirth might be especially valuable for anemic women, where loss of blood is dangerous; also in those patients whose previous history indicated a tendency toward excessive bleeding.

In India, the sinister and deadly cobra has been public enemy number one for many years. In recent times, however, scientists, many of them Indian, have turned the enemy into a friend. The cobra still kills thousands of natives each year. But in the hands of medical scientists the venom is not a weapon of death; it has become a valuable aid in the triumph over pain.

The experimenter, Macht, has

The venom of the cobra is largely neurotoxic and is one of the class used to stop intractable pain. Effect is much more enduring than opiates

demonstrated that cobra venom, like opium and morphine, relieves pain by its action on the higher centers of the brain. But, whereas the action of the opiates is quick and short-lived, the venom, on the other hand, is slower to manifest itself, though the effect lasts longer. Five mouse units of venom injected twice a week is often sufficient for alleviation of pain. Venom is not habit forming and, unlike the alkaloids, does not induce sleep. Cobra venom not only acts on the brain, but it also paralyses the sensory nerve endings. Macht injected the venom into muscles, and then showed that the sensitivity of the nerves to the shock of an electric current was diminished. Nevertheless, Macht's findings require fuller confirmation by other scientists before they can be regarded by medicine as safely established for widespread use.

Macht's investigations, when sufficiently substantiated, may add a new pain killer to the doctors' list. Already there have been scattered reports indicating its successful use in specific cases. At a hospital in Salpêtriére, France, it proved valuable in relieving cancer pain in advanced stages. In this country, two Southern physicians used it in relieving the pain of shaking palsy. In India, two native doctors, J. S. Chowan and R. N. Chopra, have had interesting results treating leprosy with cobra venom. Seventy-five percent of the lepers in that country have the nerve type of the disease; infection is primarily along the nerve lines. The suffering seems to be like that of neuritis, with muscular pains, pins-and-needles sensations, and the peculiar feeling that ants and flies are crawling on the skin. In this disease, an important factor in the restoration of health is the necessity of keeping up the patient's morale. Relief from pain is therefore a primary requirement.

Cobra venom was distributed to the various leprosy hospitals in India. It was given extensive use. The results indicated that most of the patients were afforded relief from the shooting pains of nerve leprosy. In about 6 percent of the cases the results were negative.

There is still much to be learned about the exact role of venom in the relief of pain and the cure of disease.

The venom of other animals, particularly the bee, has been tried in rheumatism and arthritis, but as yet the results have been inconclusive. Experimenters in many countries are hard at work. New preparations and new techniques are under scrutiny. Perhaps, one day . . .

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SALT LOSS

Leading Medical Journal Favors Its Replacement

THE amount of sweat excreted by workers in hot industries is known to be prodigious, at times amounting to several pints an hour. Consumption of water alone to replace abnormal loss of body fluids leads to the condition commonly referred to by miners and furnace workers as "water poisoning." Present-day knowledge of water and metabolite balance has demonstrated that the symptoms of heat cramp or heat exhaustion are not the result of overconsumption of water but rather the serious depletion of chlorides.

Normally, a man needs a daily intake of from 8 to 15 grams (about ¼ to ½ ounces) of salt to make up for chlorides eliminated in the urine and sweat. In case of excessive perspiration, considerably larger amounts of salt are required to maintain proper balance. The practice of supplying industrial workers with salt, therefore, in hot industries and in hot weather rests on sound physiologic principles. Close observation by many industrial physicians indicates that harmful results need not be expected in otherwise healthy men if there is rough approximation between salt loss and salt replacement.

Many industries, because of convenience, provide salt tablets by dispenser to be taken by the worker with each drink of water. Dextrose is frequently incorporated in the tablet on the assumption that a quick energy source is provided and that it is of value in combating shock associated with heat exhaustion. Actually, blood sugar levels in hot industry workers are not found to be measurably altered.—*Journal of the American Medical Association.*

NEW DRUG

Sulfa Drug Causes Less Nausea Than Older Treatments

ONE of the new sulfa drugs, sulfadiazine, is as effective in pneumonia and other similar infections as the best of the older chemical treatments, but with less discomfort due to the treatment, three Boston physicians, Dr. Maxwell Finland, Elias Strauss, and Osler L. Peterson, have reported to the *Journal of the American Medical Association.*

Toxic effects were relatively mild and infrequent, only 9.2 percent becoming nauseated.

Sulfadiazine was used in the treatment of 446 patients with various infections. It appeared to be highly effective in the treatment of the following diseases: pneumococcic, staphylococcic and streptococcic pneumonias; meningococcic infections; acute infections of the upper respiratory tract including sinusitis; erysipelas; acute infections of the urinary tract, particularly those associated with Escherichia coli bacilluria, and acute gonorrheal arthritis.

GONORRHEA

One More Disease Gets Its Walking Papers

COMPLETE control of gonorrhea is promised by a new treatment which cures in 100 percent of the cases, Dr. William Bromme, of Detroit, has declared, according to a *Science Service* report.

Complete cures in three days of 100 out of 100 men were achieved by sulfathiazole treatment, Dr. Bromme reported. Large doses of

the drug, averaging 60 grains a day, continued in the same dosage for 48 hours after the patient is apparently cured, are the secret of how to achieve real cures of this dangerous and often crippling disease, he said.

The patients in his series were crane operators, foundrymen, and others employed in heavy industries. None of them lost a single day from work while taking the treatment. The sulfathiazole is given by mouth. Mild nausea in 23 patients and fever of 100.6 degrees, Fahrenheit, not enough for most persons to know they had fever, in six patients, were the only reactions to the drug.

All previous methods of treating gonorrhea have failed, Dr. Bromme stated, because the drugs used could not get at the germs. It has been a common medical mistake, he said, to suppose that gonorrhea germs stayed on the surface of the infected area long enough for medicines applied to surface areas to reach the germs. It takes only a few hours for the gonococcus to get below the surface to the deeper tissues where it lives.

Sulfathiazole succeeds in killing the gonococci where other drugs have failed because it also gets below the surface. This same situation explains the failure of attempts at chemical prophylaxis of gonorrhea, Dr. Bromme believes. The disease had developed in 36 of his patients despite the use of various commercial prophylactics.

The prompt, complete cures of gonorrhea possible with adequate sulfathiazole treatment will lead to the disappearance of the crippling caused by gonorrhea. Dr. Bromme predicted that within 20 years there will not be a case of gonorrheal crippling or other complication to demonstrate to medical students.

DESENSITIZATION?

Warns Against Chewing Poison Ivy Leaves

WARNING against chewing poison ivy leaves in an attempt at desensitization to the poisonous principle of the plant appears in a report by Dr. Seymour H. Silvers, of Brooklyn, New York, in the *Journal of the American Medical Association.*

He reports the case of a woman who, having had ivy poisoning from contact with the plant for seven years, had been advised by her physician and friends to chew the leaves of the plant with the idea of preventing further attacks. As a result she had a severe eruption on her face, lips, and around her mouth, and her tongue and cheeks were so sore that she could not eat properly for two days.

Protection against ivy poisoning is frequently attempted by injecting gradually increasing doses of the poisonous principle, something like the desensitization treatments for hay fever. While it is possible to try giving this treatment by mouth, Dr. Silvers states, "it is unwise to suggest the chewing of poison ivy leaves, for the dosage cannot be controlled by this method and untoward reactions may result."—*Science Service.*

DIAGNOSIS

Detecting Viruses, Toxins, and Poisons

A NEW method of detecting viruses, toxins, poisons, and other tiny and invisible substances suspected present in liquids is disclosed in a patent recently issued to Dr. Irving Langmuir of the General Electric Research Laboratory.

The procedure, Dr. Langmuir explains, may prove useful to the study and control of biological reactions involved in the diagnosis and treatment of disease. The method provides for the immersion of a conditioned slide in a liquid containing the suspected virus, toxin, or poison, and for the measurement by optical methods of the film, usually less than a millionth of an inch thick, that adheres to the slide.

Stearic acid, a fatty acid, is spread on the clean surface of a dilute solution of barium chloride in water in a tank. A chemical reaction causes positive ions of the barium chloride to unite with the negative carboxyl group of the stearic acid to form barium stearate, an insoluble soap, on the liquid surface. A clean slide is dipped repeatedly into the tank until 47 layers of the transparent barium stearate, each 1/10,000,000 of an inch thick, have been applied smoothly to the slide. The slide then is dipped into a one percent solution of thorium nitrate.

This procedure constitutes the conditioning process which makes it possible to apply to the slide a substance that has a specific reaction toward the particular toxin, virus, poison, or other substance for which the test is to be made by an investigator.

If the suspected substance is present in the solution tested, *adsorption* of a single layer of uniformly thick atoms or molecules of the substance will take place on the slide surface, producing an increase in film thickness and a corresponding change in color.

It is known that thin films of a transparent material, such as barium stearate, reflect iridescent colors, the color of a film being dependent upon its thickness. A film which has a thickness of 47/10,000,000 of an inch reflects a purple color when illuminated by white light. If the film is made slightly thicker, the color changes toward blue. Therefore, changes in thickness can be measured by observing changes in color. In actual practice, the films commonly are illuminated by sodium light and the changes in intensity of the yellow sodium light are measured.

Each type of substance in solution is expected to produce a characteristic increase in film thickness and corresponding change in color of the conditioned slide. Once these characteristic thicknesses and colors for known substances have been determined, identification of suspected substances will be a matter of check and comparison with the established standards.

LIP CANCER

May Come from Chronic Sunburn, Not Smoking

SO-CALLED smokers' cancer, when it occurs on the lower lips of laborers, may be due to chronic inflammation from habitual sunburn and not to smoking, as has previously been believed, according to Dr. George C. Andrews, of Presbyterian Hospital, New York, reports *Science Service.*

"Sunlight, like most things that are good for us, if indulged in to excess may be harmful, even to the point of causing cancer," he said.

He sees no reason, however, for alarm on the part of persons who go in for suntan as a fad or who work in outdoor occupations, because skin cancers occur where they attract attention when still small and they can all be cured if properly treated.

A Puzzle Solved?

A New and Promising Interpretation of the Old Problem of the Solar Corona

HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

FIFTEEN years ago the spectroscopic study of the heavenly bodies left us with three great unsolved problems. We knew the origin of most of the lines and bands in the spectra of the Sun and the stars, but the dark absorption bands in the spectra of the major planets, and the bright emission lines in the spectra of the gaseous nebulae and the solar corona, had never been matched in the laboratory despite many efforts. Enough was known about atoms by that time to make it certain that these unknown spectra were not produced by atoms of some strange kinds unknown on Earth. We were sure they must be due to known elements or compounds, and suspected that they might come from common substances under unusual conditions. The discovery of their origin showed how true this was. The planetary bands are given by ammonia and methane—acting in thicknesses far greater than had been tested in the laboratory. The nebular lines turned out to be due mainly to oxygen, nitrogen, neon, and argon—literally to thin air. But the problem of the coronal spectrum still defied solution.

These lines could be investigated only during a total solar eclipse, until Lyot, in 1937, invented a most ingenious way of observing the stronger ones in sufficiently clear air. Nor are they very numerous; but 22 of them have been detected and measured, from the ultra-violet to the infra-red, and not one agrees with any known laboratory line. (A red line at λ6374 agrees closely with a line of oxygen; but three other oxygen lines, spectroscopically related to this one and always appearing together with it, are absent in the corona, so that this coincidence must be accidental.)

As time passed, the problem of these lines has become more and more puzzling. They can not be ordinary "permitted" lines—these have been thoroughly listed for all the elements. Nor can they be "forbidden" lines of the same sort that appear in the nebulae. All spectral lines (we may recall) are produced by transitions of some atom from an excited state of high energy to a state of lower energy. Normally such a transition will happen in something like a hundred-millionth part of a second; but there are other transitions so improbable that the atom must be left alone for a whole second, or even more, before they have any good chance of occurring. If an atom, in a given state, has the alternative of getting rid of its energy by a probable or an improbable transition, the number of the latter will obviously be negligibly small. But there are some "metastable" states such that, though the atom still contains more energy than in lower states, all the transitions to these are of the improbable sort. If left alone long enough, it will make one of these transitions, and unload its energy. But in a stellar atmosphere, or in an electric arc or spark, the atoms collide with one another millions of times per second, and the improbable transitions are "forbidden"—not by any absolute law of nature, but by the disturbing influence of their neighbors. In the nebulae, where the density is exceedingly low, collisions are so rare as to be negligible and the forbidden lines appear strongly.

THE density of the corona is probably quite low enough to offer no serious obstacle. But an atom can also be got out of a metastable state by absorption of light, which knocks it up to another state of much higher energy. The corona is exposed to a tremendous flood of sunlight, and metastable atoms in it would not be let alone long enough to have a chance to emit forbidden lines. This argument, due to Eddington, still holds, after allowance is made for the fact that many of these absorption lines are far in the ultra-violet, where the Sun's radiation is weak.

This apparent *impasse* has just been most ingeniously circumvented by an explanation of the coronal spectrum offered by the brilliant Swedish physicist, Dr. Edlen, of the University of Upsala. If very highly ionized atoms are present in the corona, their "permitted" absorption lines will be beyond the ordinary ultra-violet, almost in the region of soft X-rays, where the Sun's radiation is probably very weak. Such atoms would be little disturbed and would have a chance to emit these forbidden lines.

EDLEN was led to his interpretation in a different way. Having one of the very few spectrographs which will record the very short waves just mentioned, he has been systematically studying the spectra of highly ionized atoms and working out their energy levels, metastable and otherwise.

It was the German spectroscopist, Grotrian, who first noticed, in 1939, that a transition from a metastable level to the bottom-level in an iron atom which had lost nine electrons would give a line agreeing with the red coronal radiation at 6374, and that others in iron with ten electrons gone would give a fainter line at 7892.

Following this lead, Edlen identified two fainter lines in the ultra-violet as due to similar transitions in Ca XII and Ca XIII—that is, calcium atoms deprived of 11 and 12 electrons. (Ca I denotes calcium with *all* its electrons, Ca II has *one* gone; hence the apparent discordance.)

In these four cases, the spectra and energy-levels had already been worked out, so that the position of the forbidden lines could be predicted with considerable accuracy. (There is an inevitable loss of precision in working out the position of a visible line from measures in the short wave region. It is the number of waves per centimeter that really counts, and the relatively small value for the visible line is derived from the difference of two much larger numbers for short waves, so that its percentage accuracy is lower.)

The spectra of still more highly ionized atoms of iron have not yet been worked out. But, from the

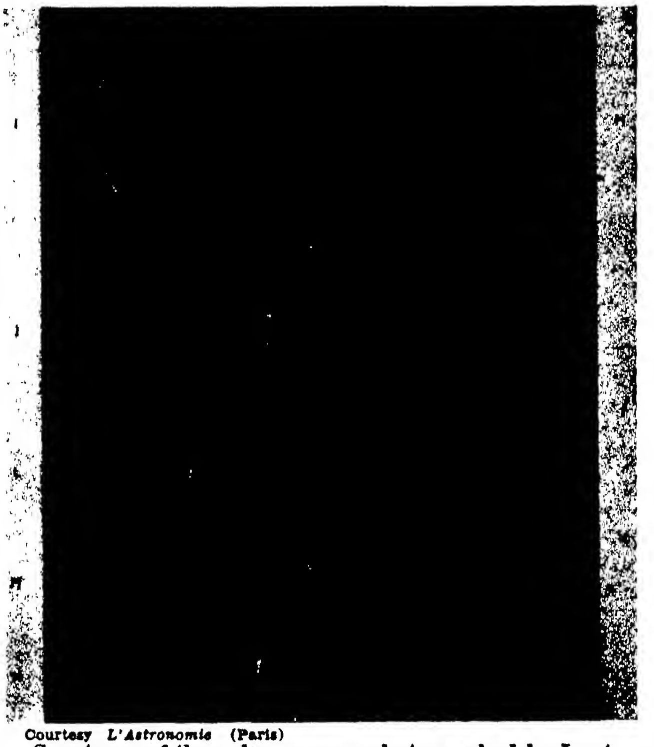
many cases already studied for different elements, it is possible to find general rules, governing the relative positions and separations of the metastable levels, which permit the extrapolation of the known data to predict those for higher degrees of ionization.

When this was done, the results were remarkable. An iron atom deprived of 13 electrons should have only one metastable state. The transition from this to the "ground-state" gives a line agreeing (within the uncertainty of prediction) with the famous green coronal line at 5303, the strongest in the whole spectrum. This is the only forbidden line of Fe XIV. For Fe XIII (12 electrons gone) there are four metastable states. The transition from the lowest of these to the bottom gives Lyot's very strong infra-red line at 10747; that from the next above to this, his other great infra-red line at 10798; while that from the third state to the second accounts for the strongest ultra-violet line, at 3388.

Seven coronal lines are now accounted for by iron atoms deprived of 9, 10, 12, or 13 electrons. Why not other numbers also? The rules of spectral structure show that an iron atom deprived of 7, 8, 14, 15, or 16 electrons has no metastable state. With 11 electrons gone there are four such states, but so grouped that transitions between them give lines too far out either in the infra-red or ultra-violet to be observed. To complete this list, we may note that iron atoms lacking from one to six electrons give forbidden lines which have been observed in novae and some peculiar stars, but not in the corona.

We can hardly ask more of iron. Its forbidden lines account for 90 percent of the whole intensity of the bright-line spectrum of the corona. Applying the same principles of prediction to other elements, Edlen identifies six more coronal lines as forbidden lines of nickel, from Ni XII to Ni XVI. Since a neutral nickel atom has 28 electrons, while iron has 26, the stripped atoms have in both cases from 13 to 17 electrons, and the spectra are similar in structure; for example, Fe X and Ni XII. The strongest of these nickel lines is at 3601. It belongs to Ni XVI and is exactly analogous to the strongest iron line at 5303.

This study gives identifications for 15 out of the 22 well-established coronal lines; but this is hardly a fair statement, as the seven remaining lines are all faint and contribute less than three percent of the total radiation. Some of these faint lines may be identified when the spectra of other elements can be studied; but potassium, chromium, manganese, and cobalt, for which good data for prediction exist, "do not account for any of the coronal lines as yet observed." These elements, by the way, are much less abundant in meteorites than iron and nickel.



Courtesy *L'Astronomie* (Paris)

Spectrum of the solar corona, photographed by Lyot with his coronagraph. Lines mentioned in the text, in the order of mention, are: 6374, in *J*, at right; 7892 in *L*; 5303 in *I*, at left; 10747 and 10798 in *M* and *N*; 3388 in *H*. The illustration is a composite

The energy required to remove so many electrons from these heavy atoms is great. To pull another electron off requires from 230 to 350 volts for the various states of iron, from 320 to 450 volts for nickel, and about 600 volts for calcium. It is noteworthy that the behavior of the lines in the corona is related to this. Lyot, some years ago, grouped the lines which appeared to be strengthened or weakened in the same regions. One group contains "200 volt" lines, and and the other correspond to about 350 volts.

Where the enormous energy required to tear the atoms so much to pieces comes from is still unknown. We have only one clue. The coronal lines — notably the green line — are very wide. Lyot, who has made the best observations, finds a width of about an Angstrom unit. Now, forbidden lines are by their nature very sharp, and the only reasonable cause for the observed widening would be rapid random motions of the atoms, ranging up to 30 km-sec in each direction. Atoms moving as fast as this would probably do each other a good deal of damage when they did collide, and this may help to account for the high ionization.

It is hard to see how these stripped atoms can maintain so high a degree of ionization if the corona, as has generally been supposed, contains many free electrons. But apparent difficulties of this sort often turn out to be guide-posts directing us to new knowledge.

One difficulty, moreover, disappears — the fact that the coronal lines have never been produced in a terrestrial laboratory. To smash even the outside of atoms to this extent, and then keep individual atoms smashed for an enormous length of time, such as a second, still far exceeds our technical capacity.

The other abundant elements in meteorites — oxygen, magnesium, aluminum, silicon, and sulfur — when ionized to the same level of energy, have no forbidden lines in the observable region.

Until such spectra as Fe XIII and Fe XIV have been thoroughly analyzed in the laboratory, Edlen's conclusion cannot be regarded as established above all doubt. But it is the first, and indeed, the only rational explanation of the spectrum that has ever appeared. The author plans to confirm and extend it, so far as his obligation of military service to his country permits. —*Princeton University Observatory, June 2, 1941.*

'Sky-Hooks' in Bridge Building

Temporary Cables Slung from Towers Help Build Fixed-Arch Span Across Niagara

HERBERT H. FOSTER

Designed to replace the famous Honeymoon Bridge, destroyed by a record ice jam in 1938, a fixed-arch bridge is nearing completion across the Niagara River and gorge. The new structure, called the Rainbow Bridge, is reported to be the largest of its type in the world. According to present plans it will be opened to traffic sometime during the fall of 1941.

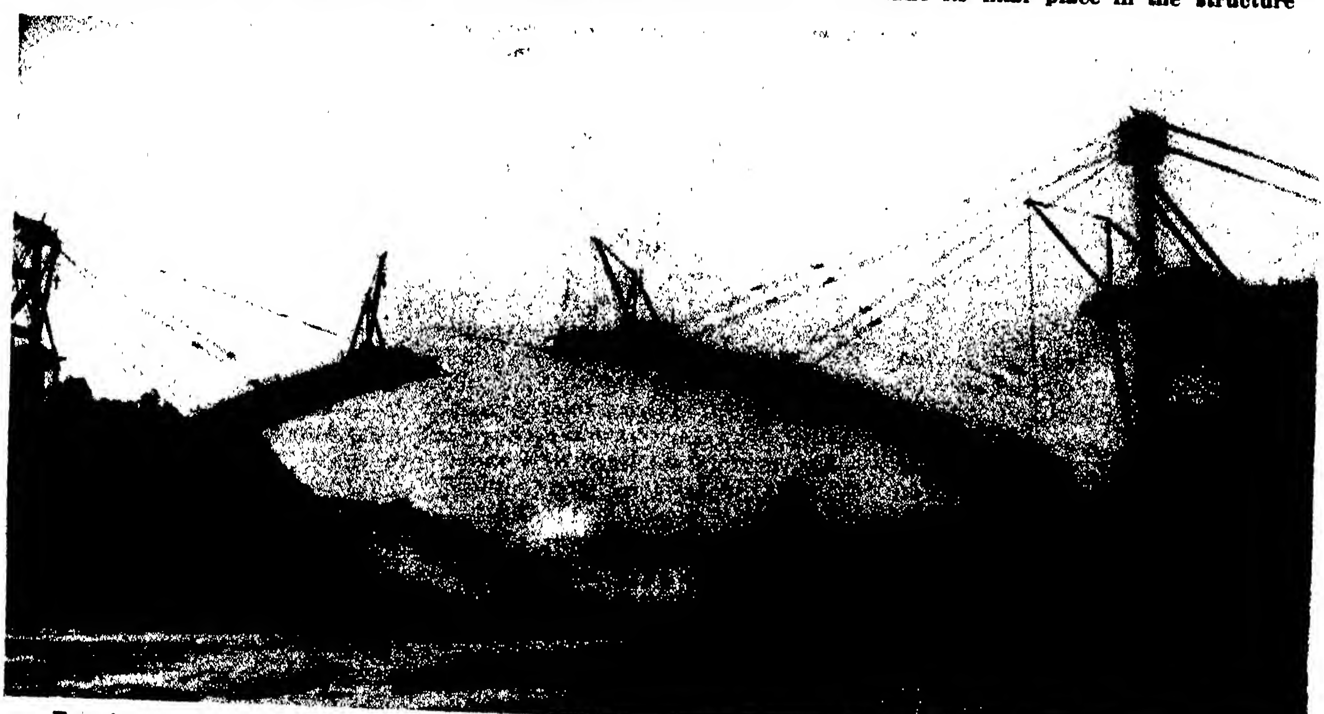
One of the engineers on this unusual project has well summarized the out-of-the-ordinary aspects of the job by stating that it was "about 90 percent engineering and only 10 percent erection." Some idea of the difficulties involved may be gleaned from the fact that the arch spans what is rated as the fastest natural flowing water in the world. Hence it was decided that it would be economically impractical to erect any kind of supporting piers or bridge substructure in the stream.

At the bridge site, the imprisoned river, forced by the falls through the narrow gorge, flows at a speed of from 25 to 30 miles an hour. At this point the stream is over 175 feet deep. It has a volume of about 6,000,000,000 pounds of water a minute.

Ground was broken for the bridge project on May 16th, 1940, at a site close to that formerly occupied by the Falls View (Honeymoon) Bridge. At this point, about 1000 feet down-stream from the American Falls, the gorge is some 200 feet deep and 1000 feet wide. The steel arch of the bridge has a span of 950 feet—the completed deck will be 1450 feet long—and rises from supporting abutments on the Canadian and American sides of the river to the level of the top of the deep gorge.

The main arch span, of the hingeless ribbed type, consists of two steel box girder ribs spaced 56 feet apart. Each section of the arch is made up of 24 girders, each 12 feet high and weighing from 49 to 75 tons. Approximately 3500 tons of steel are used in the arch and 2000 additional tons in supporting structure and decking. The two ribs of the arch are braced with

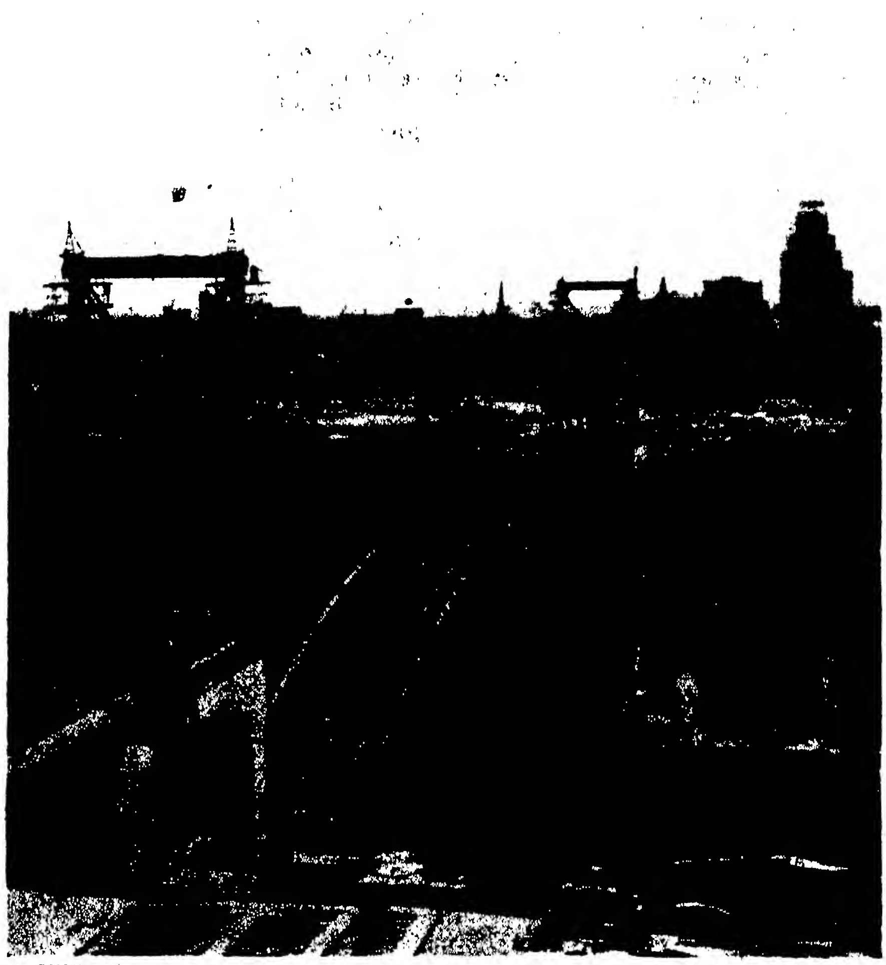
Motivated by a stiffleg derrick, 55-ton section of steel box girder moves up the curve of the Rainbow Bridge arch, to take its final place in the structure



Forming a new frame for an old vista of Niagara's cataract, the 55-ton derricks, on the shore abutments, and the 40-ton derricks, perched high on each span above Niagara River, speed construction of the Rainbow Bridge

steel members for rigidity and to resist forces produced by wind pressure and live loads.

Steel columns, resting on the arch ribs, will support the steel floor girders and concrete deck. The deck will carry two 22-foot roadways separated by a four-foot mall. A 10-foot wide sidewalk will be provided along the south side of the deck, facing the Falls. The roadways will be practically level and on grade with the natural top level of the gorge. Other than the railings, there will be no superstructure to obscure the view of the falls and the turbulent river below.



With arch completed, save for keystone, which will soon be nested between the two spans, the cables and the false-work are being removed

WITH the use of supporting substructure rejected as impractical, a method had to be devised to hold the arch girders in position during construction. Hence resort was made to a system of "sky-hooks" instead of the usual false-work. These sky-hooks consisted of a series of cables suspended from towers, which were used only during the construction and were later dismantled.

On each side of the river were built huge concrete abutment piers, located 50 feet back from the water's edge. These piers, and the approach spans, rest on solid rock; since they are placed back from the river edge they are high enough above any possible water or ice-pack level to preclude damage by forces of nature.

On top of each of the Canadian and American abutments were erected the steel sky-hook towers. At the edges of the gorge on each side were placed 85-ton derricks, and, on temporary floors built on the concrete abutments, were located 40-ton stiffleg derricks. Sections of the arch were first delivered to the edge of the gorge and then lowered by the 85-ton derrick to the smaller derrick. The first three ribs were cantilevered out and supported by the first set of cables slung from the tops of the towers. The small derrick was then moved out on the ribs and the next girders were erected. A second set of cables held these in place. Then the first cables were slacked off and lengthened to support the next girder sections. In turn, the second set of cables became the fourth and last set to support the girder sections.

The towers for holding the supporting cables were held in place by 16 other cables which were fastened to concrete anchorages weighing 650 tons and buried in rock. Similar construction methods were used on both sides of the gorge and work was carried on simultaneously from each shore.

When all of the girders were in place there was a gap of about 11 inches between the two 475-foot sections extending from each shore. In this gap were placed four 500-

Approach spans and roadway, from the Canadian side

ton jacks which took up the thrust of the two sections. These jacks will later be replaced with a steel keystone accurately machined to fit the gap. While this keystone is being fabricated, the construction equipment will be dismantled. After the keystone is inserted the deck erection will begin, the small derricks working back from the center and the large derricks working out from the sides.

The reasons given by the designing engineers for the selection of a fixed arch type of bridge for this particular job are that it saves steel and is absolutely rigid. Such construction is possible only in a location where, as at Niagara, a solid rock foundation can be secured. No definite estimate has been made as to how much the bridge will lift or sag when it expands or contracts as the temperature changes, but it is said that the variation will be so slight as to be unnoticeable.

When the entire project is complete, there will be 12 approach traffic lanes on the American side and 14 on the Canadian side, to facilitate custom's inspection.

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ANCIENT ENGINEERS: Forty centuries before telescopes made possible a greater precision, the ancients were able to orient a pyramid true north within 3 minutes 23 seconds of arc, the error being about one part in a thousand. Ordinary engineer's transits are accurate to the nearest minute.—American Antiquity.

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TUNNEL TRUCKS

Guard Against Trouble in Vehicular Tube

TRAFFIC jams in vehicular tunnels can be serious; trouble occurs occasionally and must be anticipated. Thus, stationed at either end of the Queens-Midtown Tunnel, New York City, are high-speed "trouble tractors," ready to dash into the tunnel and haul out the helpless vehicle which is causing congestion. These two tunnel guards are White tractors with superstructures and equipment designed especially for the job. A 97-inch wheelbase makes it possible to turn in a very short radius.

When a vehicle becomes stalled in the tunnel, a signal is sent to the emergency crew at the outlet of the lane involved. The tractor at that end rushes into the lane counter to the normal flow. Upon reaching the disabled vehicle, traffic in the adjoining lane is stopped just long enough for the tractor to turn around in front of the stalled machine. The turn is accomplished with only one backing and forward cut of the wheels. Then the disabled vehicle is drawn out in the same direction as it is headed.

Power steering on the tractor helps to make possible fast, short turns; a double drum winch and cables equipped with hooks make it easy to lift and tow disabled cars. Dollies, jacks, and other equipment are provided for handling wrecks promptly. In addition. the tractor carries a diversified array of fire extinguishers.

NON-SKID

Grooves in Concrete Highways Are Effective

BRUSHES with steel bristles, stroked transversely on freshly-poured concrete pavement, make grooves just right to give a maximum of non-skid quality to the wearing surface and to diminish night glare, according to experience on Oregon state highways. Since this plan was first tried some two years ago, the practice has been to finish off all Oregon concrete pavements in this way. Results are reported to be highly satisfactory, according to *Engineering News-Record.*

Ordinary brooms, lacking the stiffness of metal, do not give satisfactory results and surfaces finished with them are not nearly so "non-skid" as when the steel bristles are used. With the steel, the grooves tend to be continuous and are sharply defined; thus they aid in drainage as well as in affording grip for tires. The grooves eliminate the water film on the surface which acts as a lubricant under the tires and, at night, reflects the light of oncoming cars.

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WHERE LIES OUR POWER: Dean Potter, of Purdue University, estimates that the total power-generating capacity of the country is about 1,231,000,000 horsepower. Of this, roughly 80 percent is credited to trucks, buses, automobiles; about 7 percent to locomotives; 5½ percent to agricultural prime movers, and less than 5 percent each to central stations, mines and quarries, marine engines, and scattered sources.

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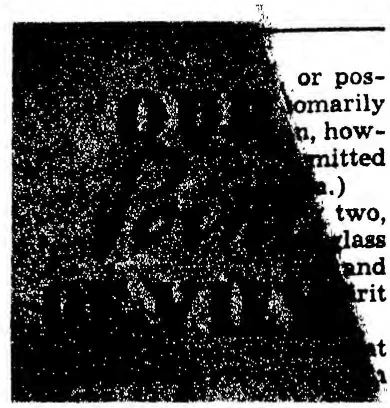
GAS STORAGE

Liquefaction of Fuel Saves Space

THE greatest quantity of natural gas stored above ground in one place, 150,000,000 cubic feet, has been concentrated in three relatively small Hortonsphere tanks at Cleveland—but in liquid form. (See also page 328, December 1940 Scientific American.—*Ed.*) The three spherical tanks, each only 57 feet in diameter, hold an amount of gas that, in its normal gaseous form, would require 50 tanks 102 feet high and 150 feet in diameter.

This is the first commercial application of the liquefaction of natural gas for concentrated storage, and it solves the peak-demand problem that has plagued the natural-gas industry for years. An ingenious method of compression and refrigeration liquefies the natural gas so that it takes up only a fraction of the space normally required. The storage tanks are heavily insulated, and when needed the liquid gas is withdrawn, heated, and moved to the gas mains in its original gaseous form.

A trouble truck tows a car out of the Queens-Midtown Tunnel



FOR THE BENEFIT OF ALL

A WEALTH of mechanical genius and inventive skill lies in that group of workers who are employed at the benches and machines of industry throughout the nation. Yet—with minor exceptions on a small scale—there has been only one organized attempt to tap this rich pool; the Revere Award, sponsored by Revere Cooper and Brass, Inc., winners of which were recently announced. Through this Award, wage earners in the broad field of the metal-working industries were encouraged to turn their talents towards inventions and processes which would speed up the defense plans of the United States in either military or industrial aspects.

Here indeed is a worthwhile means of bringing to light, and to practical use, those products of the human mind which otherwise might lie forever hidden and useless. The difficulties encountered by inventors in finding assistance in the development of their ideas are too well known to need repetition; if others in a variety of industries would follow the lead of Revere, these difficulties would be materially reduced, development work would be accelerated, and industry and the general public alike would reap the benefits.

Although the Award was opened specifically to the metal-working industries, this term was so broadly interpreted that the prize-winning entries covered a wide range of endeavor. The prizes offered totalled $10,000. First prize of $5000 was awarded for a radio system for blind landing of airplanes. Second prize, $2500, went to the inventor of an electro-magnetic riveting gun. The third prize, $1000, was given for a structural design eliminating the use of rivets and clips. Six additional prizes of $250 each were awarded for inventions as widely varying in nature as conservation of vital alloys, speeding production of ammunition supplies, a device for increasing safety and efficiency in motor transportation, a system for increasing the effectiveness of bonded metals, and a device for eliminating a large part of the manual labor in certain assembly operations.

We offer our sincere congratulations to the sponsors of the Award and to the men who so ably assisted in weighing the merits of the suggestions received from wage-earners in industry. Here is proof of the ability of the rank and file to produce ideas that are practical, useful, needed. May similar helping hands be extended in other fields to encourage inventive initiative and, by so doing, bring the resulting benefits to the nation at large.—*A. P. P.*

MEN OR MECHANIZATION?

SHOULD this nation create a mass army of 3,000,000 or 4,000,000 men and equip it with eight or ten mechanized divisions, as the War Department has planned, or should it stop at a 1,500,000-man army but equip it with at least 25 mechanized divisions? Is the military mind, in going only part way with mechanized divisions, once more exhibiting military-mindedness—the familiar old conservatism and inability to move at one step *all* the way up to the point indicated as optimum by experimental demonstration?

There is nothing profound about the reason for a many-tank force; it is rather simple. Our remote ancestors fought with their teeth, and later with bludgeons. Then came stone weapons and finally steel and firearms. Each of these advantages over tooth fighting power multiplied offensive strength several times more than the last. A parallel evolution of man-multiplying power also took place in human industry in peacetime, when man, with a relatively small, weak body and force, learned to take command of matter and force far in excess of his own bulk and strength. Now in the industrial world there is little reluctance to make full use of advances demonstrated by experiment; industry siezes on them with avidity. Why, then, is there so much slow reluctance to make the indicated advances in the art of war? Why do military minds often have to be pushed and driven into change or, if not quite that, why do they make changes so by halves instead of all the way that these often are of little or no realizable value when the trial by combat comes? The answer boils down mainly to one factor—a matter of competition. In industry there is perpetual and keen competition. In the miliary art there is less. Suppose that during about four-fifths of the time competition between industrial concerns died down from white heat to dull red. This is what happens in the military world. Less urge.

In order to bring about a major change in the world of the soldier it often has been necessary to call in a civilian—a procedure which always strikes the soldier as oddly incomprehensible. An excellent example of a civilian who, having the necessary power, used it, not reluctantly, not slowly, not half-heartedly, but as fully as demonstrations in World War I and in Spain indicated, is the present German leader. While we detest his moral principles (if any), we must not make the mistake of low-rating the paperhanger. He saw the point in mechanization, brought it about.

The tank multiplies man-muscle many times more than previous multipliers in the military realm. Intelligence controls it while inanimate matter and natural forces do its work, on a scale representing masses of men far out of proportion to its apparent scale of importance.

The remedy? There is no ideal remedy, but much will certainly be accomplished if pressure of public opinion can be brought to bear on the elderly military men who determine policy in these matters, through the people's representatives in our government. In past wars we threw human bodies and bodies and bodies against our enemies, but human bodies are poor stuff with which to stop huge forces. Present-day warfare calls strongly for tanks and tanks and tanks—non-living matter and controlled raw force. But if we fail initially to exert enough force on our military men we may find ourselves with about half as many tanks as circumstances require and about twice as many men as we really need.—*A. G. I.*

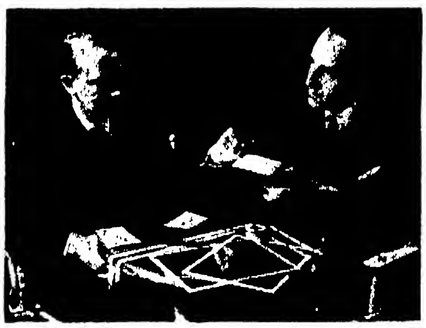
Our Search for the Supernatural—V

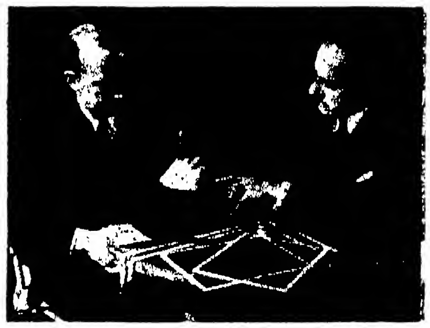
Independent Writing "Phenomenon" is Produced Through Natural Means

As described in our July issue, Reverend Edward Lester Thorne, of United Spiritualists' Church, produced before the Scientific American Committee for the Investigation of Psychic Phenomena an alleged spirit message, purportedly signed by Sir Oliver Lodge and addressed to Dunninger, Chairman of the Committee. Conceived by so-called "independent writing" and scrawled in large characters on a small, white card the message consisted of the single word, "Bottle-neck," which, according to Dunninger, is a descriptive term among magicians and exponents of legerdemain for a type of handcuffs. Although Dunninger conceded that the word "Bottle-neck" was "a sign of three things in connection with the three messages" confided to him in code by Sir Arthur Conan Doyle, Thomas Alva Edison, and Houdini prior to their respective deaths, he emphatically stated it was *not* one of the messages, nor was that word contained within any of them.

Our Committee, however, was primarily concerned with the method of production of this so-called spirit message, and whether or not it could be produced only by means of spiritistic or supernatural forces. Shortly after Reverend Thorne's seance, therefore, Dunninger, in the presence of members of our Committee, undertook to "duplicate or explain" the production of the message "through natural or scientific means," in accordance with the conditions governing the work of the Scientific American Committee for the Investigation of Psychic Phenomena. (April 1941)

Although the term "slate-writing" was originally applied to "a spiritualistic or conjuring performance, in which writing is mysteriously made upon a slate," (Webster), in more modern times it has come to encompass all forms of pneumatography, including so-called independent writing. In this connection it is interesting to note that in 1853, M. Planchette, a well known French spiritualist, invented an instrument designed for the purpose of communication with spirits. It consisted of a thin, heart-shaped piece of wood, mounted on two small wheel-castors, and carrying a pencil, point downward, for the third support. A hand was placed on the wood and the pencil wrote, presumably by spirit control through the medium. Some 25 years later an American toy-makers' firm adopted the idea, producing what was possibly a fore-runner of today's Ouija board. The latter is described by Webster as being "a trade-mark for a board, on which the alphabet and various signs are written, used with a planchette to obtain mediumistic messages." The word "ouija" was derived from the French "oui," meaning "yes," and the German "ja," likewise meaning "yes."





Left: **Cards are displayed (Step 2); message card is "accidentally" dropped.** ***Right:*** **Retrieved, message card is "forced" on the visitor**

The actual origination of "spirit-writing," of which slate-writing is a relatively modern development, is shrouded in the fog of legends and antiquity. It has been claimed that a form of the planchette, or Ouija board, was in use in the days of Pythagoras, about 540 B.C., and that followers of his celebrated doctrine held seances or meetings at which a mystic table, moving on wheels, gravitated toward signs inscribed on the surface of a stone slab. Later trace of some such form of mechanism for supposed communication with the "spirit world" is found in Scandinavian legendary lore of about the 12th Century, and has to do with a little ivory doll that drew mystical hieroglyphics for one Völsunga, a high priest of that day, who based his prophecies on the doll's writings.

Thus are found scattered records of ancestral forms of slate-writing and its development in many lands and varied forms until, about 1860 or 1865, Henry Slade, an American medium, became known principally for his slate-writing exploits. In 1876 he visited England, was cordially received, and succeeded in impressing many people until Professor Ray Lankester published in the London *Times* a letter describing one of Slade's seances. Professor Lankester claimed he had prematurely snatched the slate from the medium's hand and had found a message written thereon, although no sounds of the scratching of a slate pencil in the course of writing had been heard. As a result, Henry Slade received considerable adverse publicity, the controversy raged, and Slade was tried and found guilty in a court of law. The conviction was quashed on appeal and the medium returned to the United States, where he continued his slate-writing demonstrations for several years.

While slates of one form or another are still used by mediums, the modus operandi of slate-writing has been expanded to include almost any substance on which writing may be legible. In the case of Dr. Thorne, two sheets of single-strength window glass, seven by nine inches, with their edges taped for protection of the hands, formed a "sandwich" into which a white card, previously endorsed by Dunninger, had been placed. The glass sandwich was securely taped to the table and when the card was later removed, it bore the words, "Dunninger Bottleneck Oliver Lodge."

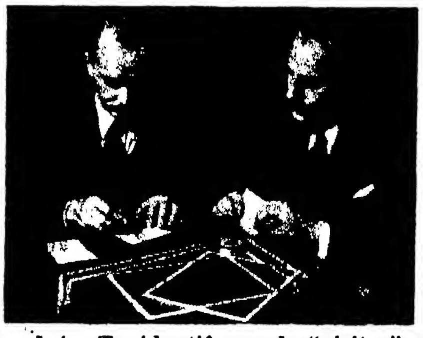
It must be remembered that the Chairman of our Committee, among his several accomplishments, is considered our ranking authority on conjury; that it was he who guided and advised Houdini when the latter assisted Scientific American in its psychic explorations of 1923 and 1924. It must also be borne in mind that Dunninger, in the course of his life work as magician, mentalist, and psychic investigator, has attended over 1000 seances, and that thus far he has witnessed nothing that he has not been able to duplicate through the conjurer's art, or explain by natural means. In so doing, his exploits have often proved so convincing that he has been accused of being "psychic," but unwilling to admit the possession of either psychic or supernatural powers.

In duplicating Dr. Thorne's demonstration of independent writing, therefore, Dunninger expressly stated that his production of a "spirit message" would be accomplished solely by means of trickery and sleight-of-hand. From a package of plain, white cards, similar to those used by Dr. Thorne, he selected one and wrote on it, "Dunninger 'Bottleneck' Oliver Lodge." This, he explained, would normally be done privately by the medium, and in advance of any public demonstration. Then, with the assistance of Mr. A. Paul Peck, member of our Committee and a representative of the Universal Council for Psychic Research, who posed as the "visitor" to a "slate-writing seance," Dunninger, taking the part of a "medium," proceeded with the performance which, for the sake of convenience in description, may be divided into six steps, as follows:

Step 1: Displaying the entire package of white cards to his "visitor," Dunninger shuffled off five from the top. Among these, face down so the writing could not be seen, was the prepared message card. Placing the balance of the package on the table, the "medium" showed the selected cards to the "visitor."

Step 2: To obviate any possible claim of trickery, however, the medium went further and hastily flipped the cards before the eyes of the "visitor." During this process one card—the prepared message card—was intentionally, but apparently accidentally, dropped, writing side *down,* on the table. After both sides of the remaining four cards had been rapidly displayed to the "visitor," the dropped card was retrieved and the entire handful, five in number, was proffered for a selection.

Step 3: To sleight-of-hand performers and card manipulators there is a technique known as a "force," by means of which the magician manages to induce the subject to choose the exact card the magician desires him to select. Through an adaptation of this trick, the "medium" caused the "visitor" to select the prepared message card.



Left: **To identify card, "visitor" writes name (Step 4).** ***Right:*** **After waiting period, seals are broken, and the "visitor" finds the message**

Step 4: Instantly after the card was "chosen," so rapidly that the eye could scarcely follow the movements, the "medium" dropped the remaining four cards, plucked the "chosen" card from the "visitor's" hand, and, placing it writing side down on the table before the "visitor," requested that he sign his name so that he could later identify the card.

Step 5: The card was then placed between the panes of glass—signature side *up* and message side *down* —and the "visitor" was permitted to tape the glass solidly to the table and to place the pencil atop the glass, leaving both pencil and card in full view. (At this point in a spiritistic seance any one of a number of procedures, such as the singing of a hymn, indulging in a period of absolute silence, or possibly a "trance" would customarily follow. In his demonstration, however, Dunninger naturally omitted this phase of the presentation.)

Step 6: After a moment or two, the "visitor" opened the glass sandwich, removed the card and found thereon the supposed "spirit message."

When, as in the case of any feat of legerdemain, a routine has been assiduously practiced and rehearsed, it is next to impossible for even the fastest eye to follow the intricate and rapid movements of the hands. In this, the members of our Committee were agreed, and they further concurred in the verdict that Dunninger had fully complied with the governing regulations by *duplicating* Dr. Thorne's performance through *natural* means.

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What They Say . . . . .

L. C. M., California: "I beg to assure you that any research in Spiritism will be a praiseworthy success and benefit to all mankind if conducted in a logical way."

B. R., Cuba: "I was surprised to read that, upon hearing it said in the voice of Mrs. Ericson, 'Tell them to take photographs,' immediately two flash bulbs were set off with blinding luminosity. You should know, my dear Mr. Dunninger, that intense light exerts a chemical, dissolving action upon the ectoplasms and the perispiritual figures or shapes which are psychically captured by the seeing mediums, a capture which cannot be obtained by those who lack this supranormal faculty or sensibility."

M. W., New York: "In reference to your offer of $15,000 for concrete information about Supernatural Phenomena, I must say that it is below your dignity and intellectual self-respect. How could you embroil yourself with the pack of frauds or gullible fools who try to communicate with the dead?"

R. C. G., Maryland: "May an old subscriber drop in for a chat by letter? Your article 'Search for the Supernatural' interested me, because from my limited personal experience, I think the supernatural, spiritistic phenomena, and mediums (fake or real) may be three problems. I believe you can go further than you dream, if it is handled right."

Bats on the Beam

Nature's "Built-in" Equipment Controls Blind Flying by Supersonic Broadcasting

LOUISE BOYDEN

WE HUMANS pride ourselves on the aids to blind flying invented in recent years, but when it comes to this field of aviation, bats are still ahead of men. They don't need the intermediary of an array of instruments on an instrument panel, as in an airplane, for their apparatus is all "built-in" and is operated just as efficiently in total darkness as in daylight. And total here means total. Bats are not blind, but neither bats nor any other animal can see anything in total darkness.

What is this mysterious sense which bats have been using for millions of years? How do they wing their way through the tortuous passages of lightless caverns without bashing into projecting rocks and invisible corners? That is a secret which scientists have been trying to solve without success for the last 150 years. Now, however, two Harvard investigators, Robert Galambos and Donald Griffin, have finally discovered the key. Through 10,000 experiments with hundreds of bats, these investigators have proved that an early theory about the blind flying of bats is actually true.

BACK in 1794 an Italian named Spallanzani found that these animals could weave their way through a maze of silk threads strung across a room, even though their eyes had been removed. In 1908 an American who substituted wires for the threads found that blinded animals made an even better showing than those with full vision, but that, if their ears were plugged with plaster of Paris, the number of collisions they made with objects increased from 25 to 66 percent. Finally, several investigators made the assumption, still unproved at the time, that somehow bats used the echoes of sounds reflected to the delicate membranes of their inner ears to guide them away from collisions. In fact, Sir Hiram Maxim, inspired by the theory (which he proposed in Scientific American in 1912) that the echoed sounds perceived by bats were those caused by air waves or pulsations from the beat of their own wings, invented an apparatus for detecting obstacles in the path of a fog-bound vessel. Low-toned vibrations sent from the bow of the ship were reflected from hidden rocks and vessels and recorded on deck by a sensitive membrane. Experimentation now has shown that the principle behind the uncanny blind flying of bats really is essentially the same as that which Maxim employed, the main point of difference being that, in place of low-toned vibrations, bats use supersonic sounds unheard by human ears.

SUPERSONIC sounds are those having a frequency above the 20,000 vibrations per second which the average human is able to detect with his ears. In flight, bats emit cries with a sound spectrum of between 30,000 and 70,000 vibrations a second.

Now, if these sounds are inaudible to us, how do we know that bats give them off? It was the impossibility of testing this that stumped scientists for a century and a half on the whole question. But modern research finds strange applications for its discoveries, and when Professor George W. Pierce, of the Harvard Physics Department, invented a device for obtaining audible beat notes from supersonic waves, the biologists Galambos and Griffin soon found a new use for it.

They placed bats in a sound-proof room with a supersonic detector and observed that, when the creatures were held quietly in the hand, no supersonic waves were recorded; as soon as the bats began to fly, however, the audible beat-notes from high-frequency sounds poured forth from the loud speaker. To give an idea of these volleys of staccato sounds, we may compare them in their impression to radio static during a bad electric storm.

It therefore seemed clear that bats give off cries with a very high frequency, and it remained only to be ascertained whether they really depend on them in avoiding obstacles.

To test this hypothesis, Galambos and Griffin erected a gauntlet in the sound-proof room. They suspended a number of steel wires vertically from the ceiling to the floor, with a 12-inch path between each pair of one-millimeter wires. It was then up to the bat to steer a course between these obstacles without the aid of eyesight. Considering that its wingspread was nine to ten inches, there wasn't much more than an inch of clearance on either side. This test of bat skill would be like asking the pilot of a plane having a 30-foot wingspread to fly along an opening only 36 feet wide between two wires an inch and a half in diameter — a difficult stunt even for an aviator guided by vision.

The Harvard scientists found, however, that, even if a bat's eyes were heavily coated with collodion, it could dodge between these barriers, without even brushing, 75 times out of every 100 trials.

Now what is the outcome if the bat is deprived of its hearing? By tying each bag-like ear of an animal around a tiny glass tube passing to its inner ear, Galambos and Griffin arranged it so that, by filling the tube with cotton or taking the cotton out, they could alternately close off the inner ear or leave it open. What happened whenever the ears were completely plugged provides a convincing piece of evidence. First of all, the bats were very reluctant to fly. Most of the time they preferred to sit on the floor and dig frantically at the offending ear plugs. When they were forced to take to their wings by being picked up and dropped in mid-air, they bumped into walls, collided with wires, and finally dropped to the floor or clung to a wall. They behaved just like a blind man in an unfamiliar room. They fumbled. They were confused. From a score of 25 collisions per 100 trials made by blindfolded bats that could hear, these deafened bats jumped to a bad score of 65. As soon, however, as the tubes were unplugged, the percentage of collisions fell again to 25.

The next step in the experimentation was to find out what would take place if the bats were

made voiceless. This was a little more difficult. But the Harvard investigators were able to gag the animal temporarily by first tying its snoutlike mouth with linen thread and then sealing the lips with collodion. The result was that the score of collisions again jumped to 65 percent. The supersonic broadcaster — that is, the bat — could no longer give off volleys of sound as it flew.

Just to make doubly sure that the supersonic sounds really were cries rising in the animal's larynx, Galambos and Griffin made two more observations.

In one, they found that, if they held the bat's head for short periods under water, during these periods no high frequency sounds came forth from the recording apparatus.

In the other, by looking at the back of the bat's throat through a microscope, they were able to see movements of the membranes at the base of the tongue, and these movements coincided with the supersonic sounds recorded by the detector.

Another bit of evidence is the fact that one can hardly imagine an instrument better fitted to produce high-frequency cries than the membranes of the larynx of a bat. Like the E string of a violin, they are fine, and they are capable of being stretched by the tension of a very strong musculature.

But the most dramatic sign-post to the way bats use their cries in blind flying came again through the supersonic detector. On a moving tape attached to the machine was traced a curve showing the frequency of bursts of sound in numbers per second. This varied according to the bat's position with regard to the obstacle. It started at 30 bursts per second when the animal was flying in the clear at its normal rate of five feet a second. Then, when the bat approached within about ten feet from the wire, suddenly the rate jumped to 50 per second. As the animal drew still nearer to the wire, the bursts slowed down gradually to 30 and continued at that speed as the bat veered away and avoided the obstacle. But, when a bat was prevented from using its ears, these staccato volleys of sound did not change their rate, no matter what the bat's position or distance with regard to the wires. The explanation seems to be this: As the bat approached the wire, the echoes of its cries were reflected from the obstacle to its inner ears. Speeding up the cries had the effect of producing more and sharper echoes. This, in turn, gave the bat a clear idea of its orientation with regard to the obstacle.

Robert Galambos, one of the two Harvard investigators, bat, supersonic detector

Courtesy *New England Naturalist*

The common little brown bat, much enlarged (weight one fourth ounce), which had crawled into a crevice in a Vermont cave, to hibernate

All these experiments were performed in a laboratory with isolated bats. What happens in nature, where the same cave is alive with hundreds of them? Does each individual recognize its own supersonic cries? Galambos and Griffin have discovered that they can follow the progress of individual bats as they fly along passages toward the exit. If the human ear, aided by a complicated apparatus, is able to distinguish one bat's cry from that of another, it would appear that the bats themselves should be able to accomplish the same feat with their own highly sensitized equipment.

Copyright, *New England Naturalist*

Investigating bats in a cave at East Dorset, Vermont

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YOUR BREATH

A Little Discovery That May Turn Out Bigger

Two hundred million particles in every breath a person exhales are the reason that the breath is visible on a clear, cold morning.

Discovery of these particles, each nearly 100 times as big as an air

molecule and which were previously unknown to science, was announced recently by Dr. George R. Wait, of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, reports *Science Service*. The majority of the particles are stated to be electrically charged, either positively or negatively.

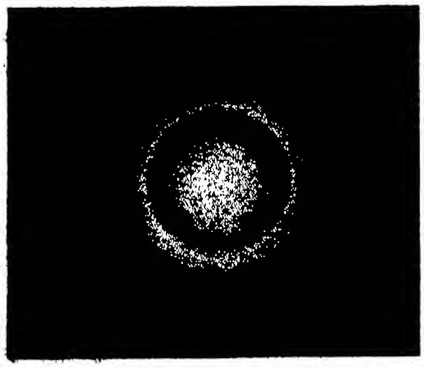
Such particles, Dr. Wait said, are common in the air over chimneys and in the exhausts of automobiles. Perhaps those in the breath, he suggests, are the "smoke" of the fires of life itself, the constant burning in the body which keeps up its temperature. On a cold morning, moisture condenses around these particles and becomes visible. The particles from the lungs, in a room where several people are assembled, quickly capture smaller ions, or broken air molecules, already present. Dr. Wait suggests that perhaps the breath particles play some part, as yet unknown, as carriers of disease-bearing microörganisms.

ELECTRONIC CAMERA

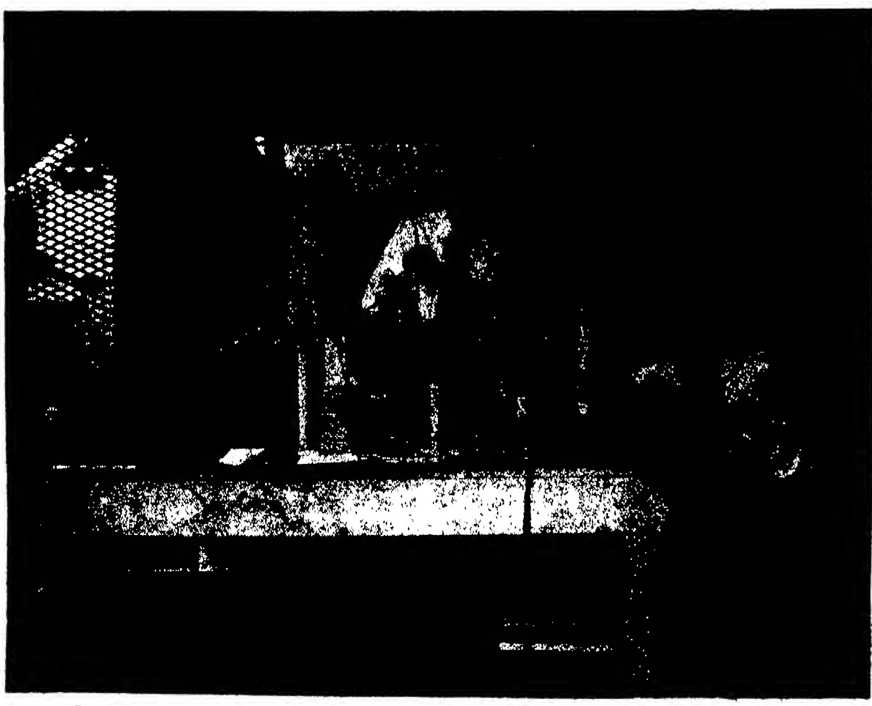
Studies Thin Films of Crystals, Supplements X-Ray Studies

An electronic vacuum camera that photographs the crystalline structure of substances measured in millionths of an inch in thickness has been built by Dr. Ralph P. Johnson of the General Electric Research Laboratory. The camera is being used to study deposits on the surfaces of metals, like tarnish, lubricants (such as grease and oil), and the first stages of corrosion. It supplements X-ray apparatus that permits study of the interior of substances of greater thicknesses.

The camera proper consists of a brass tube, about three and one-half feet long, and a focusing magnet. A 40,000-volt electronic beam enters one end of the tube, is focused by means of the magnet upon the material suspended in the middle of the tube, diffracts, and produces a picture upon a lantern slide at the other end of the tube. The tube is evacuated to permit free passage of the electronic beam without collision with gas molecules. The material to be photographed is suspended in such a way that it can be raised or lowered or tilted at any angle to the beam.

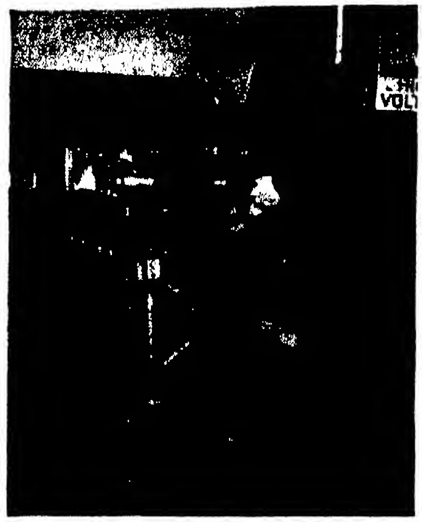


How electronic camera reveals the electronic pattern of gold



Using the electronic camera built by General Electric engineers

Thus electron diffraction has become a powerful supplement to X-ray diffraction in the study of matter, and the electron diffraction camera has taken its place in the laboratory as an important research tool.



The electronic camera of RCA

Another electron diffraction camera has been developed by Dr. J. E. Ruedy in the RCA Research Laboratories for use in the study of electron emitters. With it the structure of films or surface layers only a few atoms thick may be readily analyzed.

RADIO MIRROR

Counting Meteors in Cloudy Weather and Daytime

When a meteor passes through the atmosphere many miles above the ground, it leaves behind it a radio mirror, a line of broken atoms, which may last for many minutes. By sending radio waves up, and measuring the time of the echo produced by their return, these meteor mirrors may be detected, Dr. J. A. Pierce, of the Cruft Laboratory of Harvard University, reports in the *Physical Review*. In this way, it may be possible to count meteors even in the daytime or in cloudy weather when ordinary means fail.

Astronomers are greatly interested in checking the number of meteors entering the Earth's atmosphere, but cloudy weather, and daylight, prevent the records from being complete. Possibly the radio method may be a solution to this previously baffling problem.

If You Value Your Eyes...

Eye Protective Glasses Must be Correctly Designed for the Job They Have to Accomplish

EDGAR D. TILLYER, Sc.D.
American Optical Company

THE natural protective mechanism of the eye is sufficient to adapt it to ordinary intensities of illumination; to conserve eyesight, however — in addition to having refractive errors corrected and diseased conditions treated — excessive light radiation should be controlled. Thus the increase in outdoor sports and eye-hazardous industrial operations such as welding has posed a problem of adequate eye protection against excessive visible and invisible rays.

For example, when intense infra-red radiation is present, the burning sensation which follows exposure gives a quick warning and consequently it is not so likely to cause injury. The presence of ultra-violet radiation, however, is not felt at the time of exposure and is only revealed by the discomfort and suffering which develops a few hours after the real damage is done. Since the invisible rays are of no aid to vision, it is wise to minimize the risk of injury, in questionable cases, by wearing glasses which cut down glaring light and also absorb the invisible rays.

Fortunately, science in recent years has developed special lenses, the properties of which are such that they afford protection against harmful radiation. Such lenses have particular value now in view of the tremendous increase in welding and furnace and foundry operations brought about by the national defense program. The history of the development of these lenses goes back many years. As a matter of fact, long before welding glass came into existence, or sun glasses achieved their present popularity, scientists were seriously at work to discover some practical means of visual protection.

Aucott, in 1561, suggested a spectacle lens of green glass as of "great public utility and benefit," while Pierson, in 1672, championed the cause of blue lenses. Gray or smoke glass lenses were produced and sold in London in 1767. The manufacture of amber lenses was licensed by Royal Patent of George IV in 1832, this step practically completing the color scale and laying the groundwork on which science was later to evaluate the relative merits of the various shades and tints.

Both pilot and passenger are wearing eye-protective lenses which soften glare, absorb invisible rays

Developments followed rapidly at the turn of the century and certain lenses were developed with the actual objective of excluding from the eye the harmful emanations of infra-red and ultra-violet rays. Some of these lenses succeeded better than others, but all have been practically forgotten in the rapid scientific progress made in the past 30 years.

The first really scientific attempt in an organized field to control light emanations was undertaken in 1909 by Sir William Crookes who, as a member of the Glass Workers Cataract Committee of the Royal Society, attacked the problem of eye protection. Crookes made several hundred experimental glasses and, in 1913, after four years of arduous labor, produced a glass of sage green color with good infra-red cut-out; also a glass for ordinary use which cuts out ultra-violet and which today bears the name of the famous English inventor.

At that time a glass with cut-out in both ultra-violet and infra-red, while still retaining complete visual transmission, was a chemical impossibility. In a paper, "The Preparation of Eye-Preserving Glass for Spectacles," read by Crookes before the Royal Society, he stated:

". . . The ideal glass which will transmit all colors of the spectrum, cutting off the invisible rays at each end, is still to be discovered. As far as transparency, however, is concerned it will not be an unmixed advantage for the sought-for glass to be quite clear and colorless. The glare of a strong light on white cliffs, expanses of snow, electric light, etc., is known to be injurious to the eye and, therefore, a tinted glass combining good obstruction to the heat radiation and ultra-violet rays is the best to aim for."

In the face of these findings, research scientists of American Optical Company undertook active experimental work. In 1924, after years of investigation and research, it was discovered that, by a careful balancing of ferrous and ferric iron ingredients and the addition of other oxides, an olive green glass could be made which gave a peak of maximum transmission of useful light closely coinciding with the peak of the curve of eye sensitivity, and at the same time gave the highest possible ultra-violet and infra-red absorption.

Absorptive lenses protect the welder's eyes

The first use of the new glass was in the industrial field where those exposed to glare found the glass gave definite protection against radiation which tired and irritated eyes.

Later, in an attempt to solve the cause of aviator's headaches and eyestrain, the United States Air Corps investigated the possibility of using the glass for flying. Tests under actual flying conditions proved that, for high, continuous flight, the glass gave eye relief never before experienced, a cooling effect being particularly noticeable. It was also found that in Air Corps field reconnaisance, observation, and piloting the glass did not distort color values—an important point, since the detection of false color and untrue foliage is essential to successful flying operations.

Another factor had to be considered. The lenses of earlier goggles were mechanically designed without regard for optics. No attention had been paid to the fact that a deeply curved lens of zero focal power, such as used in aviation goggles, actually had an optical center which must be properly placed just as would be done if the lens had power like an ordinary prescription lens.

After wearing such defective lenses for short periods of time, they caused severe headaches which decreased the pilot's efficiency. It was therefore necessary to create a new optically designed lens out of the new glass. This lens permitted true eye-coördination and therefore accurate, comfortable seeing. On wearing the new lenses, the fliers were delighted to discover that their headaches had vanished.

On the basis of this relief from eyestrain and glare, the new type absorptive lenses were adopted as standard by the United States Army Air Corps and specifications were set up as follows: "The anti-glare glass shall be known as Calobar, or its equivalent . . . the glass shall have high absorption throughout the ultra-violet and near infra-red regions of the spectrum, in order to protect the eye from harmful effects of intense sunlight."

Although its scientific protective values were recognized, the new glass did not come in for its full share of useful application until the popular acceptance of the sun glass. Colored glasses probably gained fashionable reception because of glamor appeal, a fad started by motion picture stars who wore them day or night as a symbol of incognito, as a cloak of psuedo-invisibility.

The public quickly discovered this same glamor appeal and also that cheap, inferior sun glasses may be dangerous to wear. A non-absorptive dark glass will actually allow more rays to reach the eye than if the glass is not worn. This is because the darkness of the glass causes the pupil to open up, making a larger entrance for the unwanted radiation.

Industrial developments of comparatively recent origin, such as arc or flame welding, high-temperature furnaces, and the like, have made necessary the use of very dark glasses, transmitting as little as 0.01 percent of visible radiation. Such glasses, in addition to reducing the amount of light transmitted, must also reduce the transmission of infra-red and ultra-violet to such an extent that these undesired and harmful radiations are reduced to an amount less than that of the visible light transmitted. Twenty-five years ago a welding glass that transmitted less than 25 percent of the total energy of a high intensity source, however dark the glass, was a rarity. Now 0.01 percent total energy transmission would be considered high in the better glasses.

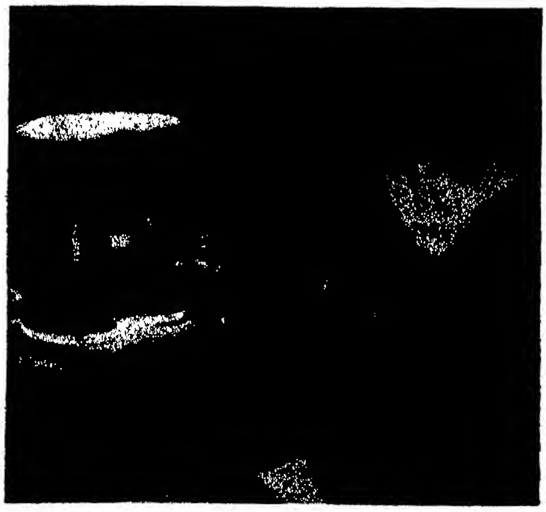
Modern welding glasses must also be strong absorbers in the ultra-violet, in which welding arcs, especially those of high amperages, are very rich. By the use of glass compositions containing as much 9 percent iron oxide, suitably balanced between ferrous and ferric iron compounds, both infra-red and ultra-violet are reduced to the desired extent.

Several years ago a young Boston physicist, Edwin H. Land, developed a polarizing material which, adapted to sun glasses, does a remarkable job of eye-protection by eliminating reflected glare that is so annoying outdoors, particularly when motoring.

This Polaroid material is a flexible cellulosic sheet, unlimited in area, in which are embedded billions of polarizing crystals per square inch, all lying parallel. For protection, the material is always laminated between sheets of glass or heavy safety film.

Like slightly darkened celluloid in appearance, Polaroid material combs out the light which passes through, arranging the light waves so that they all vibrate in parallel planes. It is as if a beam of ordinary light were like the random waves moving helter-skelter along a rope, tied at one end, and moved about, in all directions, at the other. If the rope passes through a gap in a picket fence, all of the vibrations will not get through, but the ones that do will all be parallel with the gap between the palings.

In practice, the light beam's "fence" is Polaroid material. After it has passed through, its vibra-



Visual transmission curves of types of glass are plotted with a spectrophotometer

tions are all arranged in the same plane. It is this arrangement of the vibrations in one plane that makes them controllable, for when a second "fence" of Polaroid is placed in the path of the light, with its "pickets" at right angles to that of the first Polaroid, the vibrations cannot pass and no light gets through.

When the eye looks at any non-metallic surface, it gathers two kinds of light: the diffuse light with which it sees color and detail; and the specular (mirror-like) reflection of the light source, usually thought of as glare. This specular reflection is always partly, often entirely, polarized by the action of the reflecting surface. The amount of polarization depends upon the angle of reflection and the refractive index of the material. The diffuse light, however, is not polarized; by viewing the surface through Polaroid material it is possible to reduce the apparent brightness of the reflections without changing the relative brightness of the diffuse light.

In short, Polaroid sun glasses choose between the useful light with which the eye sees detail, and the reflected glare which is always useless in vision and often blinding. Their advantages outdoors are obvious. Motorists drive with added safety and comfort with road-glare eliminated. Yachtsmen obtain the added benefit of seeing shoals and buoys formerly hidden by reflected glare from water. Skaters, golfers, skiers, and beach enthusiasts find their vision improved and their eye-comfort increased by the scientific glare-elimination. The Polaroid material also cuts out ultra-violet.

What constitutes a good eye-protective glass? Briefly, in addition to absorptive properties, the lenses should be essentially free from flaws (striae, bubbles, seeds, and so on); the surfaces should be essentially free from defects (waves, scratches, and grayness); and the finished lenses should be essentially free from prismatic effect and focal power, regardless of the process by which made.

As it is obviously impractical to determine in a receiving room or at a sales counter whether or not a sun-glass lens conforms to the foregoing standards, the Sun Glass Institute recently established a basis for certification of quality by manufacturers. The certification is in the form of a label which is applied only to sun glasses having lenses that measure up to certain specified standards. The certification label, therefore, serves the profession, the trade, and the public as a means of identifying good sun-glass lenses.

It should also be pointed out that certain high-grade sun-glass lenses can be ground to prescription to correct defective vision, thereby providing protection for those who must have a correction in their glasses.

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TELEDELTOS

Electric Recording Paper Now Available for Wide Use

Sometime ago in these columns was described a recording paper developed by Western Union for use in automatic telegraphy. This paper is sensitive to electricity much as photographic film is sensitive to light. It is acted upon by a tiny metal stylus to turn the paper surface to a permanent black at any point where current passes through it.

Once Teledeltos was a closely guarded secret but it has recently attracted considerable attention in the scientific world, since it simplifies many recording processes, and is now being used extensively by manufacturers and users of recording instruments such as fathometers (for measuring ocean depths), electro-cardiographs, devices for measuring the speed of machinery, and for other purposes.

COOL

Headband for Use On Hot Jobs

A modern perspiration retainer for men working on hot jobs, called the Coolband, has been made available by Mine Safety Appliance Company. When men are working under conditions of extreme temperature Coolband provides greater comfort and safety by preventing sweat from falling into the eyes or onto goggles or glasses.

The band, providing all-around-the-head absorption, consists of a soft, flexible band which clings softly without binding. A cooling effect is maintained through constant absorption of perspiration. Sanitation is easily maintained as the band may be disinfected as frequently as necessary. When the band becomes saturated it can be quickly removed and easily wrung free from excess moisture.

Cool, sanitary, comfortable

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HIGHWAY TO HEAVEN: San Diego County and the state of California spent $1,500,000 building a special road to the top of Mt. Palomar, 65 miles northeast of San Diego, so that the people could drive up there without difficulty, and this they may do today. The telescope is there, practically ready, except for the main mirror due to be completed in 1942 or later.

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UNDERWATER

Air Trap Conserves Swimmers' Energy

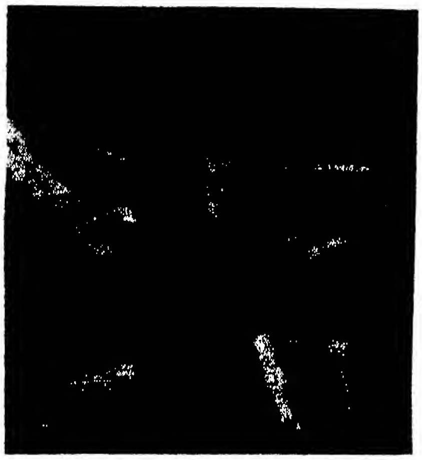
A "filling station" for swimmers' lungs and an "observation booth" for swimming coaches is being used at Wakulla Springs in Florida. This unique air trap has a roof of crystal clear "Lucite" methyl methacrylate resin plastic, formed in a half-cylinder shape, with ends of solid cypress and an approximate radius of 18 inches. Air is pumped into this half-cylinder trap through a hose leading down from the surface.

The air-filled half cylinder is held to the base of the trap by four three-foot studs. The base is a rectangular box 14 inches deep filled with ballast to anchor the trap to the bottom.

A swimmer merely dives to the trap, swims in between any two studs, and sticks his head up into

the large, half-cylinder air space. The trap accommodates four swimmers at one time, and they may sit on the ballast box and converse while "refilling."

The trap is particularly useful at Wakulla Springs, a thriving center of underwater photography



Underwater lung "filling station"

where the clear water permits vision at great depths. Swimmers performing for the cameras at depths of 15 to 20 feet exert too much energy in rising to refill their lungs; the trap allows them to conserve this energy.

Further, the trap enables a swimming coach to observe his students as they swim above him, and to point out to proteges in the trap defects in another swimmer's style.

BALANCE

New Checks Assure Automobile Smoothness

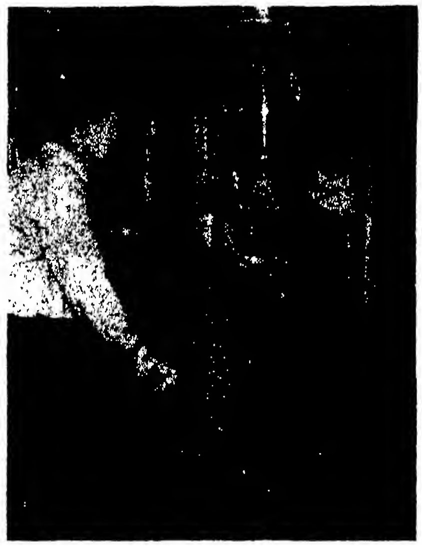
The importance of balance in vibrationless operation, not only of engines, but also in many other vital elements of the car, is emphasized in a new phase of the manufacturing program now being conducted by Buick. As a result of developments along this line, the balancing of parts going into the manufacture of current models and the design of special machinery and equipment for balancing purposes, has become a major element both in manufacturing processes and design of parts.

The balancing of automobile engines after assembly is the latest step in the campaign for perfectly balanced motor cars. Technically, the balancing operation is regarded as a complete safeguard against the possible production of a "rough engine." Engineers point out that with rotating and reciprocal parts held to within fractional plus or minus limits of perfect balance, the completed engine is normally "in the money." It is possible, however, to have a stacking up of limits in which all of the fractions would be on the plus or all on the minus side. This could result in a "rough" engine. The after assembly balancing operation virtually eliminates this possibility and places each engine in perfect balance within limits of 1/4 of an ounce-inch.

Throughout the years of motorcar development it has been a major problem of engineers to reduce vibration, from whatever source, to meet the manifold requirements of smoothness in operation, elimination of noise and the important factor of reduction of wear on moving parts. With the development of high compression, high power, high performance automobile engines, the question of fine balance in all engine parts as well as the various chassis units, and including even the bodies, has become of relatively greater importance than in the past.

The extent to which Buick already has gone into balancing is indicated by the fact that there are 10 separate balancing operations in the engine plant covering vital parts: The harmonic balancer assembly is balanced to within 1/4 of an ounce-inch; the clutch pressure plate 1/4 of an ounce-inch; clutch cover and pressure plate assembly is held to 1/4 of an ounce-inch limits; the clutch driven plate assembly is balanced to within limits of 1/8 of an ounce-inch; flywheel is held to 1/8 of an ounce-inch; the crankshaft to 3/8 of an ounce-inch; and the completed engine to 1/4 of an ounce-inch.

Special types of balancing machines are used to calibrate connecting rods. The rods are checked on the balancing machine, indicators are set to proper limits and



Spinning detects un-balance

milling cutters automatically advance to remove sufficient stock, if necessary, so that when the rods are placed on the two knife edges of the checking scale, the limit of 1/16 of an ounce on either end will not be exceeded. Similarly, pistons

Final check on the over-all balance of an automobile engine

are measured, weighed, and fitted in a controlled temperature room and likewise held to 1/16-ounce limits.

Extension of complete balancing operations to other parts of the chassis include the balancing of third member assemblies — drive shaft, torque tube, flanges and bearings — and rear axle sub-assemblies. Thorough checking of the dynamic balance of rotating parts is positive insurance against the incidence of undiscoverable rumbles and other noise in finished cars, engineers say.

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TENDERS: The capacity of passenger locomotive tenders ranges from 4500 to 24,500 gallons, with the average between 15,000 and 18,000 gallons. Tenders employed in freight service have a capacity ranging from 7000 to 30,000 gallons, the most common being from 16,000 to 22,000 gallons.

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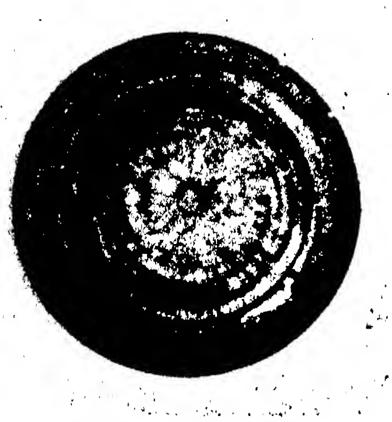
FOSSIL PEARLS

The Principle of Pearl Formation Stays Fixed

A RECENT geologic discovery revealed the presence of several fossil pearls that gave indication of being closely akin to species that exist today. Professor George F. Sternberg, of the Fort Hays Kansas State College, found the pearls in the Benton shales, of Cretaceous age, near Hays, Kansas. These shales, and consequently the pearls they harbor, are approximately

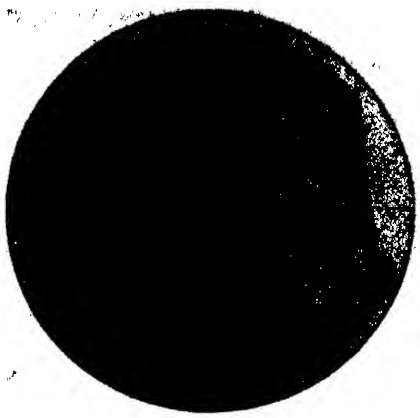


Cretaceous pearl

100,000,000 years old, as shown by the geologist's time-table.

One of these fossil pearls, which had been donated to the Bureau of Natural Pearl Information by Professor Sternberg, was thin-sectioned and subsequently examined microscopically. It was found that there exists a striking similarity in structure and constitution, when the pearl of today is compared with the gem of 100,000,000 years ago.

In one of our photographs, representing the ancient pearl, is revealed a crystalline habit that strongly resembles that found in certain species of pearls of recent origin, of which the second picture is typical.



Modern pearl

Both of these pearls are composed of the hexagonal variety of calcium carbonate—that is, calcite—and therefore differ from other natural pearls which are composed of the orthorhombic variety of calcium carbonate—aragonite.—*A. E. Alexander, Ph.D.*

SUN-SWITCH

Photo-Electric Control for Light and Power

A NEW photo-electric relay for lighting and power, called the Sun-switch, is used to control electrical circuits in accordance with the rise and fall of natural illumination. The user chooses the two lighting levels at which he wishes the load switched on and off, and he adjusts the calibrated dials to the corresponding foot-candle readings. Operation is entirely automatic, no resetting being necessary.

The photo-electric switch is primarily designed as an aid to greater safety and economy in incandescent lighting applications. Important advantages result from using the device in this service, including: Lighting will always be on when needed, regardless of when darkness comes; Lighting will never be on when the presence of sufficient daylight makes it unnecessary; No one need be made responsible for, nor take the time to do, the job of lighting up.

Sun-switch automatic control, developed by the United Cinephone Corporation, may advantageously be applied to: aircraft beacons, airport lights, street and highway illumination, billboards and spectacular type signs, department and retail store lighting, factory lighting indoors (to guard the eyes of workers), factory lighting outdoors (plant protection floodlights), schools, libraries, museums, hospitals, railroad stations, public buildings, and other similar lighting jobs where automatic control can logically be applied.

Special care has been taken in the construction of the switch to make the control rugged and capable of delivering reliable performance. The housing is weatherproof, of drawn metal, 10¾ by 5⅜ by 3½ inches. The door gasket is cork; finish of box is aluminum. The control circuit uses a phototube having a life expectancy of 20,000 hours. Operation is from 110 volts, 50 or 60 cycles, alternating current.

SKIN PROTECTOR

Forms Film to Protect Hands and Work

A WATER-WHITE liquid into which a shop-worker dips his hands prior to starting on a job dries quickly to form a skin protecting film. Not only is the skin protected but the film also prevents perspiration from coming in contact with the surface of delicate or finely finished metal parts on which perspiration could cause rusting to start. This liquid, designated as Ply No. 9, has been placed on the market by the Milburn Company.

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CONTACT LENSES: Today about 8000 people are wearing contact lenses over the eyeball, in place of eyeglasses of the conventional type.

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PLASTIGLASSES

Contact Lenses Now Made of Plastics

THE same transparent methyl methacrylate plastic now used for many products can also be used for contact lenses, the invisible glasses that are worn under the

eyelids. This is provided for by patent Number 2,240,157, granted to Louis L. Gagnon and Harold R. Moulton, Southbridge, Massachusetts, who assigned their rights to the American Optical Company.

The use of plastic, states the patent, "causes the lens to be exceptionally light in weight and resistant to impact and possible fracture."

Another feature is that in the area where the lens makes contact with the eyeball, a thin coating is used of a plastic material which is first soft, and can then be hardened. It is applied while soft, so it takes the form of the eyeball with great accuracy, thus adding to the comfort of the wearer.—*Science Service.*

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COMPETITORS ADVERTISED: The per capita consumption of apples has dropped nearly 75 percent during the past 20 years, and the products that have replaced apples in the diet of the average American family are those which have been highly advertised, particularly other fruits and canned and fresh fruit juices.

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OXOSHIRT

Diving Apparatus for Life Guards, Sportsmen, and Workers

A LIFE-SAVING "oxygen shirt" to aid life guards in rescuing drowning persons has been invented by Dr. Christian J. Lambertsen, of the University of Pennsylvania Medical School. With this apparatus strapped like a harness to his bronzed back and chest, the life guard will be able to stay under water for from 18 to 25 minutes in depths to 60 feet while searching for drowning accident victims, instead of the usual one minute at depths to 30 feet.

The oxygen harness which thus increases the life guard's life-saving ability weighs just over 12 pounds in air, according to *Science Service.* Under water it is practically weightless. A small cylinder for oxygen or an oxygen-nitrogen mixture fits into a pocket. A nose and mouth mask, rebreathing bags, lead plate, and a soda lime container are the other chief features. The breathing bags, breathing tubes, and inhaler are all buoyant under water and their lift almost exactly balances the under-water weight of the oxygen cylinder, regulator, soda lime container, and lead plate.

The whole life-saving apparatus can be strapped on and be in use within 15 seconds or less. Unlike the deep-sea diver's outfit, it does not require an assistant at the surface but it does not give protection against cold while under the water.

Besides helping life guards and others rescue drowning persons, the new apparatus could be used for inspection and minor under-water repairs of hulls of boats; for pearl and sponge fishing; sport, as in goggle fishing; and, with slight modifications, in mines, sewers, and chemical plants, where the atmosphere is deficient in oxygen or contains noxious gases.

RHODOPSIN

Substance in Eye Makes Ten Somersaults a Second

HUMAN vision is made possible by a mysterious substance in the eye known as rhodopsin, contained in the rods of the retina. When light falls upon it, reports the Better Vision Institute, it undergoes a chemical change. The alteration of the substance causes a nervous impulse which is transmitted to the brain.

Rhodopsin has the remarkable ability of changing itself back to its original form in about one sixth of a second. In normal eyes these chemical somersaults take place about 10 times a second, hour after hour, day after day, year after year. The substance may be compared to the sensitive coating on a photographic film, but with the remarkable difference, however, in its power to change itself quickly after exposure to its original form.

TRAFFIC SPEEDUP

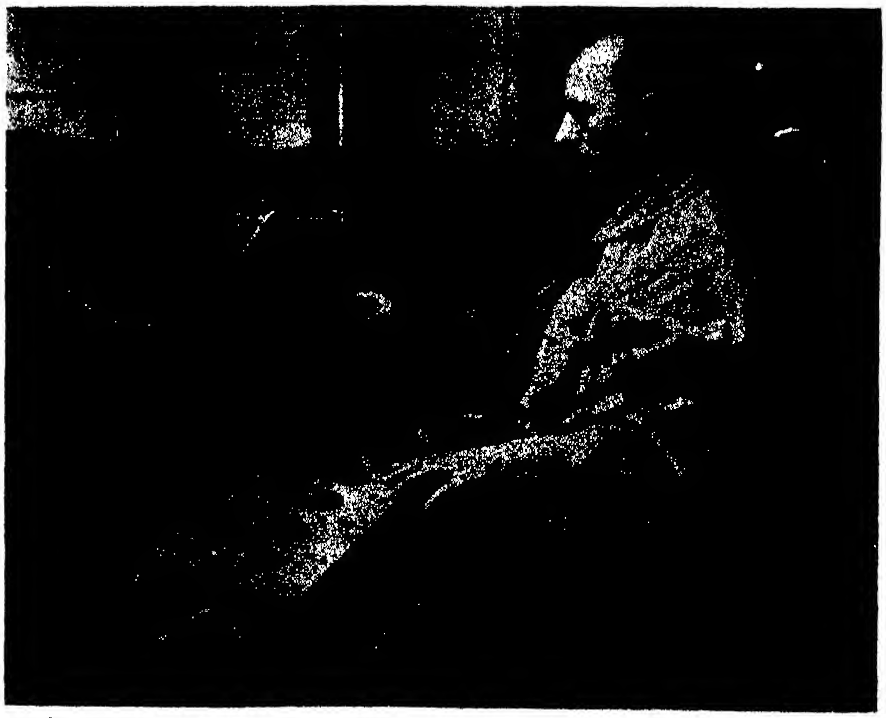
Surface Transportation Company Uses Two-Way Radio

RADIO is now being used to speed up bus and trolley traffic in New York through a fleet of 20 patrol cars operated by the Brooklyn and Queens Division of the New York Transit System. By means of these cars, controlled from a central dispatching office, busses and trolleys can be quickly and effectively routed around traffic jams.

COMPRESSION

Water Measures Ratio in Engine

ACCURATE determination of the volume of the combustion chamber in an automobile engine cylinder head is essential in the production of well-designed motors. One of our illustrations shows a method used by Pontiac to measure accurately the size of these chambers. Since the size of the chamber governs the motor's compression ratio, it follows that by determining the cubical capacity of the chamber,



Accurately gaged water provides check on cylinder compression ratios

Books on Psychic Phenomena

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Extra-Sensory Perception After Sixty Years

By J. B. Rhine, J. G. Pratt, Burke M. Smith, Charles E. Stewart, and Joseph A. Greenwood

A COMPLETE account of the research conducted to date on extra-sensory perception. This book is a summary of what has been achieved so far, a reference work covering the field as a whole, a treatment of all the evidence, a guide to the literature of the subject, a condensation of the greater bulk of it, and a handbook of methods. It includes a digest of 56 articles of criticism of experiments in extra-sensory perception, mainly as made by psychologists, in which these are dealt with without emotion. A solid, serious study. (463 pages, illustrations.)—$2.85 postpaid.

Forty Years of Psychic Research

By Hamlin Garland

AFTER a lifetime spent in investigating spiritualistic phenomena, the author presented the facts as he observed them. He theorized little, witnessed without emotion, and after a clearly stated, factual presentation, he permits the reader to draw his own conclusions. (394 pages.)—$3.60 postpaid.

Cavalcade of the Supernatural

By Dr. Harold H. U. Cross

HIGHLY valued as one of the clearest, most convincing volumes dealing with manifestations all over the world of water divining, luminous effects, materializations, spirit photography. Illustrated with authentic pictures.—$2.10 postpaid.

Experiments in Psychics

By F. W. Warrick

INTENDED for experienced students of psychic phenomena, this book records the results of years of systematic investigation of direct writing and psychic photography. A large number of experiments, accompanied by photographic studies, all made under test conditions, seems, in view of the convincing nature of results, to rule out the possibility of fraud in the majority of cases and to offer strong evidence in favor of the types of psychic phenomena dealt with. (600 illustrations.)—$7.60 postpaid.

DUNNINGER

YOU, TOO

Can Investigate The

SUPERNATURAL

IN our April issue we announced our intention of exploring the realm of the psychic in an endeavor to determine whether, through mediums, we can communicate with the dead. We want to know if such things as phantoms, ghosts, spirits, or vampires actually visit us. We seek the facts concerning ectoplasmic and other supernatural demonstrations of a physical nature. To aid us in our search, the Scientific American Committee for the Investigation of Psychic Phenomena was formed under the chairmanship of Dunninger, whose world-wide reputation as a telepathist, magician, and psychic investigator is unequalled.

In the course of our search the Committee will welcome sincere and bona fide assistance. Should your interest in the psychic lead you to try to discover for yourself a basic, truthful, scientific explanation, you will wish to follow the reports of the Committee as they appear in ensuing issues of Scientific American. For correlative reading, the books listed on this page will be found informative, helpful, and interesting.

—The Editors

Books on Psychic Phenomena

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Inside the Medium's Cabinet

By Dunninger

A DARING exposé of trickery practiced by fraudulent mediums in presentation of so-called supernatural phenomena. In an exciting series of revelations, this internationally known authority on spiritistic matters divulges the secrets of certain mediumistic personalities who have come within the scope of his experience. Every statement of fact is based on the author's first-hand investigation. (228 pages, profusely illustrated.)—$2.60 postpaid.

Psychics and Mediums

By Gertrude Ogden Tubby

A MANUAL and bibliography for students, this is also an important guide and source book, presenting a scientific analysis of all types of psychic research, both objective and subjective. (210 pages.)—$2.10 postpaid.

Science and Psychical Phenomena

By G. N. M Tyrrell

IF the world is to be saved from the advance of materialism, the author points out, knowledge of man's psychic processes must be extended. This splendidly informed, thoroughly scientific examination of a controversial but increasingly important subject is a unique addition to the literature on psychical research. Brilliantly concise, carefully evaluated, the history of research and the method of collective experiment are described. —$3.85 postpaid.

Beyond Normal Cognition

By Dr. John F. Thomas, Ph. D.

THIS is an intensely interesting study, evaluative and methodological, of the mental content of certain trance phenomena. The author was for some years associated with the Boston Society for Psychic Research. (319 pages, bound in cloth.) —$3.10 postpaid.

it is possible to check accurately the compression ratio in all the cylinders of the engine. In the set-up shown in the photograph the glass tube containing water is graduated in cubic centimeters. The volume limit of the combustion chamber in a 6-cylinder Pontiac engine is 93.8 to 97.8 cubic centimeters; for an 8-cylinder engine the limit is from 69.9 to 73.5.

DRESS FORM

Plastic-Saturated Fabric Reproduces Feminine Figure

SCIENCE has come to the aid of the dressmaker by providing a form which makes it possible to fit women's clothes exactly in accordance with the most minute figure variations.

In making the form, sheets of a plastic-saturated fabric are molded to every line and curve of the human figure, being applied over a smooth fitting cotton garment. The soft plastic material is molded carefully to conform to the body like a second skin. The shell thus formed hardens almost immediately whereupon one side is re-opened and the shell is removed. The resulting dress form is reinforced, lacquered, and mounted on an adjustable stand.

The thermoplastic material used for this form, made of rubber combined with a variety of waxes, was developed in the research laboratories of the Singer Sewing Machine Company. These ingredients are melted together and used to saturate a knitted fabric. The finished material is stated to be non-inflammable, non-toxic, inexpensive, and easy to apply. The sheets of thermoplastic material are merely warmed to a few degrees above body temperature just prior to molding the figure.

COMFORT

Keeping the Home Cool in Summer

MEANS of removing heat from the attic make houses more comfortable. Louvers of average size in the gables are said to be of little value, and small openings in the cornice do not help much. Louvered openings as large as ordinary windows are cooling, but must be closed in winter. Additional ventilation through cornices and ridge ventilators is also desirable. Light-colored roofs absorb less heat than dark-colored roofs. The house-construction experts say there is no use expecting very noticeable results from adopting only one of these factors, but all of them together will produce a very considerable effect in keeping houses cooler. — United States Department of Agriculture.

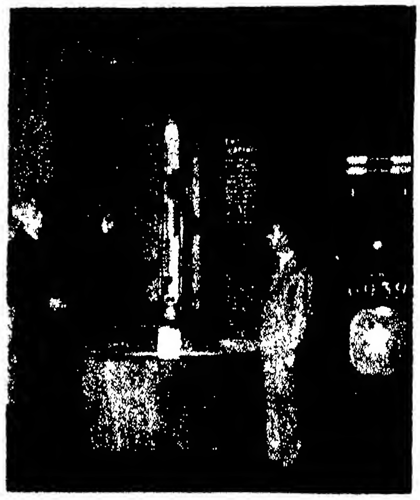
TIME CAPSULE

Replica of Historical Record for 6939 A.D.

BURIED 50 feet underground at the site of the New York World's Fair of 1939-40 is the Westinghouse Time Capsule described in some detail in these pages when first constructed. There it will remain until uncovered by archeologists thousands of years hence, revealing to the people of that far-distant day a complete record of the early 20th Century.

That the people of the present day may be able to see precisely how this record was made for future generations, a replica of the Time Capsule was recently placed on display at the Hayden Planetarium in New York City.

A glass-covered cutaway in the capsule allows the public to see how the contents are packed. Among the articles visible are a Bible, the Book of Records, a tele-



Replica of preserved records

phone, a baseball, glass tubes of various seeds, and containers of microfilm on which is recorded a 10,000,000 word synopsis of the history, faiths, arts, sciences, and customs of our civilization.

PURIFYING

ON PAGE 337 of our June issue we described in some detail a water purifying process employing synthetic resins. This method, which employs a reaction similar to the zeolite process of water softening, has been made possible through experimental work conducted by the Resinous Products and Chemical Company.

SCIENCE IN INDUSTRY

Industrial Growth

New Products and Processes That Reflect Applications of Research to Industrial Production

ALL-GLASS TAPE

Woven Glass Material Provided with Adhesive Back

FIBER-GLASS adhesive tape with a pressure-sensitive coating has been perfected by the Industrial Tape Corporation. It was originally designed for use as pipe insulation but is now being used in various industrial fields and is finding increasing uses in the electrical industry and in other businesses where flexible glass tape is needed.

The glass tape is manufactured in 40-inch rolls and then cut to any desired width exactly as paper and cloth tapes are cut; in use it is applied and cut just as any other adhesive tape.

FILE

Works on Soft Metals Without Clogging

CALLED "A Modern File for Modern Industry," a newly patented tool is provided with spaces between the teeth to allow the chips to pass through. Thus the file works like

a plane with a multiplicity of blades and will not clog even when working on the softest metal. The chips are cleared with a flick of

The chips go through

the wrist, all brushing or scraping of clogged teeth being eliminated. This file, known as the "Zipper," is manufactured by the Delta File Works and can be used on flat or slightly convex or slightly concave surfaces. The aluminum handle has an adjustable turnbuckle by means of which the body of the file can be slightly curved.

VARIABLE SPEED

Adjustable Pulleys

For Wide Power Range

Now available on the market is a complete variable-speed pulley drive which can be used on installations of from one to eight horsepower where a maximum speed ratio of 3 to 1 is desired. With this complete drive setup, manufactured by the Ideal Commutator

Increases or decreases speed of old machines to fit requirements

Dresser Company, old fixed-speed equipment can be modernized at low cost and made to operate at the most efficient speed for the work in hand.

Both halves of the adjustable pulley move toward or away from

the center line; the belt always remains in the correct plane. The faces of the pulley are curved, giving maximum belt contact at all pitch diameters. The adjustable pulley mounts directly on the motor shaft.

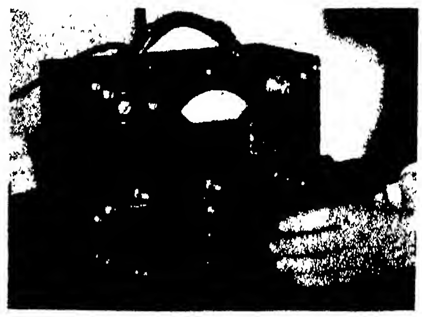
THICKNESS GAGE

For Measuring Non-Magnetic Materials

AN ELECTRIC gage for measuring the thickness of any non-magnetic metal when only one side is accessible has been built by the General Electric Company. Thicknesses up to 1½ inches, depending upon the electrical resistance of the metal, can be measured within an accuracy of 5 percent.

Although the instrument was particularly designed for checking the wall thickness of aluminum airplane propellers, it can also be applied to the measurement of brass sheeting, copper tanks, and large pipes.

The gage consists essentially of a bridge circuit, voltage amplifying equipment and an indicating



For thickness measurement

instrument. The bridge circuit comprises two inductances with U-shaped cores and a differential transformer. The inductances serve as a gage head and an adjustable balancing head.

The gage head, when placed against a non-magnetic metal, sets up eddy currents within the metal which change the impedance of the head and affect the circuit bridge balance. The eddy currents increase with the thicknesses of the metal.

The effects of these eddy currents upon the bridge circuit, as shown by deflection of the indicating scale, are plotted upon a master curve for known thicknesses of a specific metal within the desired thickness range.

The gage head then is placed against the unknown thickness of that same metal and the scale de-

flection read. This reading is compared with a similar point on the master curve to determine the thickness of the tested piece. It is essential that the contour of the test piece be the same as that of the pieces of known thicknesses from which the master curve was obtained.

The higher the electrical resistivity of the metal the greater the thickness that can be measured. With this gage, which operates on 50 to 60 cycle alternating current, brass, which has a comparatively high resistivity, can be measured in thicknesses up to 1½ inches, whereas copper, which has a low resistivity, can be measured only to ¼ inch thickness.

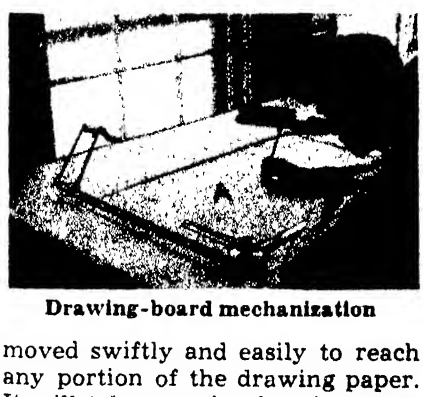
The gage head, encased in Bakelite, can be held in one hand for application against the metal. The remainder of the gage is contained in a steel carrying case and weighs about 30 pounds.

DRAFTING

Machine Speeds Up Drawing Board Work

A DEVICE which mechanizes the drawing board, known as Master-Drafto and made available by The Drafto Company, has been particularly designed for industries where ideas must be quickly translated into production.

When permanently mounted on the drafting board or table, this new device combines the use of scales, triangles, and T-square into one operation. The scales, attached to the protractor plate, can be moved swiftly and easily to reach any portion of the drawing paper. It will take any size drawing sheet up to 24 by 36 inches.



Drawing-board mechanization

The stainless-steel protractor plate, at the ends of the arms, can be set to one-half degree readings by use of a graduated vernier. By tightening the clamping device the scale blades can be locked at any angle desired. The protractor is fitted with a latch spring to lock

the scales in any one of four different positions on either side of the zero reading.

CORROSION PROOF

Metal Surfaces Protected in Storage or Transit

A NEW liquid material, known as Pro-Cote and manufactured by Fisholene Inc., is designed to protect the finish of metal surfaces while they are stored or in transit. The liquid dries to a transparent corrosion-proof film which permits ready inspection of the parts. After a film has served its purpose it is removed by rubbing with a dry cloth.

TRANSFER FILM

Aids in Speeding Up Defense Production

DEVELOPMENT of Matte Transfer Film, a photographic material for sensitizing metal plates for use in a template process that shortens the time between engineering and test flights in the aircraft industry from two to four months, is announced by the Eastman Kodak Company. The process can also be effectively used in the automobile industry or by any manufacturer using metal templates, nameplates, and so on.

With the use of Matte Transfer Film, engineering drawings can be printed either by contact or by projection on photo-sensitive metal sheets. The processed plates bearing the photographic image are then sent directly to the template department to be cut out and used as a pattern. The templates are made by cutting around the photographic outline by means of a saw or mechanical shears. Other machining operations to which the photo-sensitized metal sheets are subjected are filing, drilling and punching. By this means the costly and time-consuming step of making the layouts on metal by hand from the blueprints, or the necessity of duplicate inspection, is avoided.

If great care is taken in the selection of the cameras and lenses used for this purpose, it is reported that photo-templates can be made with a tolerance of 0.001 inch per foot.

It has been found that the most simple and effective method of producing sheets of photo-sensitized metal consists of laminating Matte Transfer Film to lacquered metal sheets. The film consists of a sensitive emulsion coated on a thin film support, the latter backed by a paper base. When used, the sensitized strip is transferred (or stripped) from the supporting paper base to the lacquered metal plate. This film has a matte surface, so that it will take a pencil line in case changes or additional developments on the processed photographic image are desired.

TOOL GRINDER

A NEW and larger carbide tool grinder of the double end type, designed so that two operators can grind tools simultaneously, has been announced by Carboloy Company, Inc. The high capacity of the new machine makes it particularly suitable for plants where a large number of carbide tools are being used or ground daily, for use where large amounts of carbide removal are required, and where heavy-duty cemented carbide turning, boring, facing, or planer tools, and so on, are to be conditioned.

The grinder is designed for the use of two 14-inch disk type wheels—one at either end; each end has its individually adjustable tool rest table. The grinder may thus be used, if desired, for rough and finish grinding, or for rough and semi-finish grinding before lapping.

Two can grind

To facilitate handling of large tools, tool rest tables are exceptionally large—9 by 22 inches. They are individually adjustable by means of screws operated through detachable crank handles, graduations being provided on the side of the table to assure accurate setting.

Air Fighters

Characteristics Desirable in the Military Type that Keeps Bombers Away

ALEXANDER KLEMIN
Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University.

An acknowledged authority on military aircraft, E. Colston Shepherd, editor of *The London Aeroplane,* has recently published a pamphlet on his chosen subject. Some of his observations will certainly bear consideration, particularly by our own military forces.

Fighters and bombers are drawing closer together. Ten years ago the fighter was faster than the bomber by a good 30 percent. Today the fighter's margin represents a bare 15 percent; but the fighter will never disappear, because nothing but the fighter is a real defense against the bomber. Anti-aircraft fire can keep the bomber high, break up formations, and impair the accuracy of its bombing; but only the fighter can destroy the bomber before it drops its bombs, only the fighter can make daylight bombing too costly for the enemy. When, last September, the Royal Air Force claimed 185 victims in one day, the British had won their first great victory of the war—without the public realizing the fact. What was the secret of the British victory? "Making allowance for the better training and finer spirit of the British pilots, the German onslaught on Great Britain was beaten by slightly better fighter aircraft," writes Mr. Shepherd. "The superiority was expressed partly in speed, partly in power of maneuver, partly in armament."

Mr. Shepherd elaborates on these three essentials of the fighter. In regard to maneuverability: "Yet the Messerschmidt 110, with its four forward firing machine-guns and two cannons, to say nothing of its speed of 365 miles per hour, has often been shot down by the older Hurricanes, capable only of 330 miles per hour and carrying only eight machine-guns, which have a shorter effective range and less penetrative power against armor than cannon. The secret has lain in the power of the Hurricane to turn more quickly than the bigger machine and so to give it bursts of fire from positions in which it could not reply."

What is the ideal specification for a fighter? "Probably the ideal fighter would be one about 50 miles per hour faster than the best bomber, and armed with eight small cannon able to fire shells at the rate of 600 a minute each for a period of about three minutes. If to these characteristics could be added a range of 2000 miles, an initial rate of climb of 4000 feet a minute, and a ceiling of 45,000 feet, then the lucky air force would have obtained an instrument which would take the heart out of its opponents. Before the war is over there may be such a fighter. For the present the nations have to be content with something less formidable. Fighters have not yet passed out of the stage of mixed armament — machine-guns and small cannon." Here is a specification which our military designers would do well to study. Free from fear of invasion or bombing, with the physical and mental resources of a continent behind them, why should not we be able to build a machine that would give the British and ourselves complete superiority over the Germans?

FLAPS

Air Brakes for Dive Bombers

There is no danger in great diving speed, be it as high as 600 miles an hour; the danger comes in the subsequent recovery and the large centrifugal forces developed in a curved flight path. When the diving speed is very high, the radius of the recovery curve must also be high; otherwise the centrifugal forces would be enormous. The airplane might be built to withstand such forces, but the pilot would suffer a blackout of his brain. Flaps or air brakes may therefore be used to keep the diving speed within reasonable limits. Without flaps, diving speed is high, the radius of recovery is large, the

height from which the bomb must be released is considerable and the aim is uncertain. With wing flaps is set up a combination of circumstances which is much more pleasing to the bomber—lower diving speed, small radius of recovery, release of the bomb fairly close to the ground, and greater certainty of hitting the target—*A. K.*

FLYING BOAT

Most Powerful Patrol Bomber

Even the old line Admirals in the Navy Building were perturbed by the story of the sinking of the *Bismarck,* and are almost though not quite ready to admit that sea power without air power cannot exist. However, the Bureau of Aeronautics in the Navy Department has been fully aware of the value of the fleet air arm and of the patrol bomber for many years, and can be proud of the fact that its air effort is modern and efficient.

The most powerful of the long range patrol bombers is the PB2Y-2, a four-engined craft built by Consolidated Aircraft Corporation and shown in flight in our photograph. The PB2Y-2 is a big sister ship to the hundreds of Consolidated twin-engined patrol bombers which have been giving such useful service to the Navy under the designation of PBY.

Certainly the giant four-engined flying boat has a beauty of its own. The huge hull looks as if it had no more resistance than the most perfectly streamlined fuselage of a land aircraft. The bomber's compartment in the nose is perfectly streamlined into the rest of the hull. The windshield protrudes very little. The gun blister at the rear is nicely faired into the top of the hull. The nacelles of the engines stick very far out ahead of the wing, partly no doubt to secure trim, but also as a method of attaining aerodynamic efficiency. The tip floats have been retracted into the tip of the wing. The vertical tail surfaces are out at the ends of the stabilizer, increasing the efficiency of the stabilizer, and are themselves out of all blanketing effects of the fuselage.

No further information is available regarding these large boats, but they look as if they could give the Germans quite a little to worry about.—*A. K.*

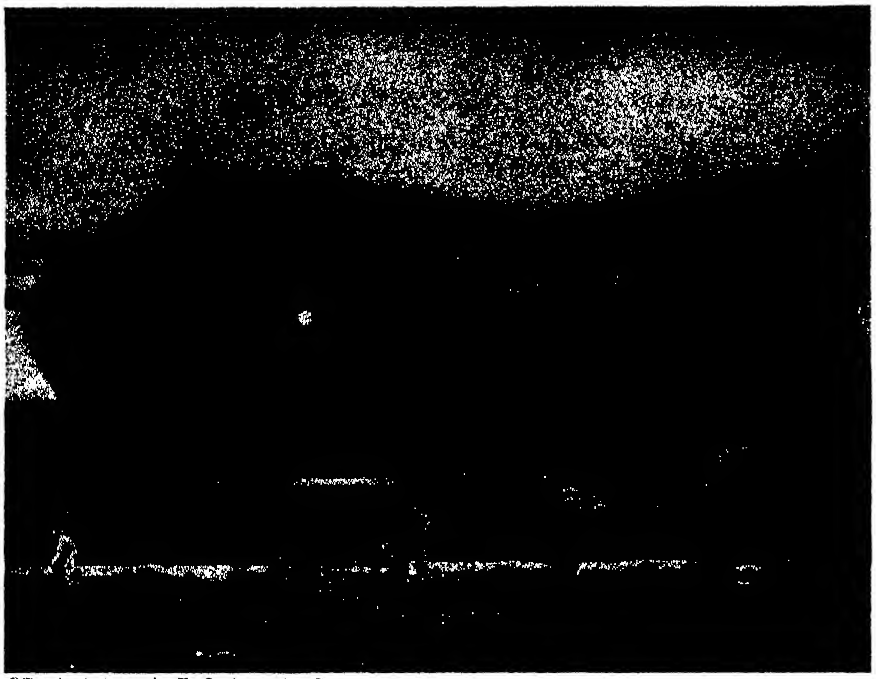
BALLOONS

An Important Factor in National Defense

The barrage balloon has proved itself of the utmost value in England. It forces dive bombers and other attacking planes to fly at high altitudes, thus decreasing their effectiveness. The development of this method of defense has been the duty of the Army Air Corps; its use will be the duty of the Coast Artillery Corps.

In principle, the barrage balloon is extremely simple. All it has to do is to stay put, not tear away (even in the most violent wind) from the wires which attach it to the ground, not lose gas too rapidly, be able to withstand a good deal of wear and tear, and be capable of being let out or hauled down rapidly and easily. In actuality

Four-engined patrol bomber—most powerful, clean



Official photograph, U. S. Army Air Corps.
Handling a barrage balloon at Camp Davis, North Carolina

its design problems are difficult. The average size of the barrage balloon, when inflated, is 35 feet in diameter and 87 feet in length. It should be reasonably stable when aloft; that is to say, it should neither nose up too much and pull away in a high wind, nor nose down and lose altitude. Hence the provision of the very large tail surfaces, since the balloon body itself is inherently unstable. In the modern balloon the outer covering is of cotton fabric, impregnated with synthetic rubber. Experiments have shown that the synthetic product holds hydrogen gas better than natural rubber.

It is perfectly proper for our War Department to expand its balloon barrage facilities. They will constitute a valuable defense measure in protecting fleet anchorages, localities where it is difficult for planes to intercept enemy aircraft, and so on.—*A. K.*

AIRCRAFT ARMOR

New Process Speeds-up Production

We are indebted to the magazine *Steel* for an excellent description of a new process for manufacturing airplane armor plate, developed by the Breeze Corporations.

The severe limitations on airplane weight require that the gage of the armor plate be as light as possible, consistent with effective resistance to the projectile. Thus, airplane armor ranges up to 44 inches by 44 inches by 1½ inches, most of it being in ¼, ⅜, and ½ of an inch in thicknesses. Armor plate is essentially a nickel-alloy steel. It must be exceedingly hard on the exposed side; tough but more ductile on the interior side.

How is this additional hardness on the exposed side achieved? By carburization; that is, by heat treatment of the surface while in contact with a powder having a high percentage of carbon content. The face-hardened armor plate is thus given extra resistance to penetration.

The Breeze armor plate is as good as any built in the world, but, what is perhaps of most interest in these days when production must be speeded up at all costs, is the much faster carburization process which has been developed. In common practice the plate is packed in a box of carbon powder and placed in a heating furnace. Since the box may weigh twice as much as the steel which is being treated, considerable time and heat are consumed before the contents are raised to the desired temperature. As much as 50 hours may be required for a complete heat for ¼-inch plate. In the new Breeze process, three heats can be carried out on 24 hours. The carburizing treatment is accomplished with a liquid salt bath in an electric furnace. This equipment enables the work to be charged and removed quickly, brings the plates up to the desired temperature quickly and makes accurate control of the temperature possible.—*A. K.*

CAMERA ANGLES

Conducted by JACOB DESCHIN, A.R.P.S.

Bar-Less Zoo Shots

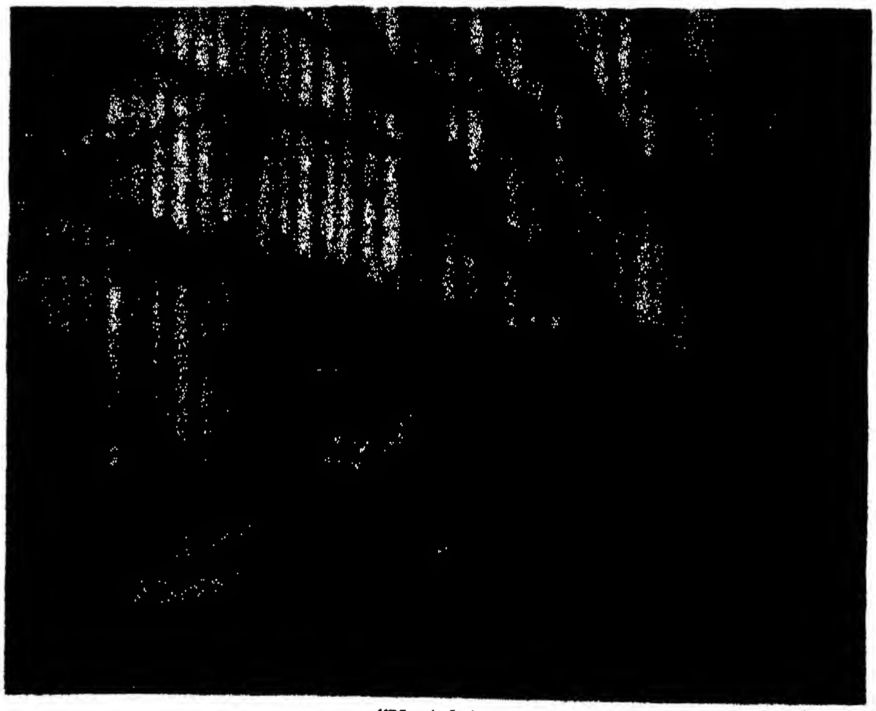
A TREND very heartening to amateur photographers who have had to think up all sorts of tricks to get around the iron-bar problem in shooting natural pictures of animals and birds in the zoos, is currently under way. In several city zoos, lions have the run of a plain, arranged convincingly like the African habitat whence they came, fully open to the view. However, a dry, deep moat separates the edge of the plain from the sightseers—and camera fans, who can now shoot at leisure from a safe vantage point, without bars and with plenty of opportunity for composition and all the other details of picture-making.

However, for really good shots, we believe a long focus lens to be indispensable. The best shots of the king of beasts are, as we all know, made fairly close up or, what amounts to the same thing, at a distance but within the narrow angle of view of the telephoto lens. The fellow with the one-lens camera need not be discouraged, however, if he will only remember that, by cropping a small part of the negative, he achieves practically a telephoto effect in his print. Of course, this makes it mandatory that the film be developed in a fine-grain solution to insure grainless enlargements.

If you have the time to stick around long enough, or the patience and interest to keep coming back to the grounds every once in a while during your peregrinations through the zoo, you will find there is more variety in this subject than may at first appear. Now, the beasts are resting near a rock or a tree, singly or in groups of two or three; now they are strolling down the plain toward the edge of the moat; now they are playing or fighting, sometimes three and four of them at one time. The picture reproduced was made on 35mm film in a camera equipped with a long focus lens. The subject faces the setting sun, completely relaxed and but mildly curious about the people on the other side of the moat. His thoughts seem a long way off.

Large birds also have the run of a plain open to the view without bars. Most of them move around rather leisurely so that it is not difficult to

"Busybody"



"Nostalgia"

shoot them at leisure, provided they come close enough for a decent size picture; others, like the strutting secretary bird you see in the picture, keep moving all the time and you have to be on your toes to get them quickly. The thing to do in this case is to work in good light when you can, close down the diaphragm to permit a fairly deep field of sharp focus, and shoot when the subject comes within reasonable range.

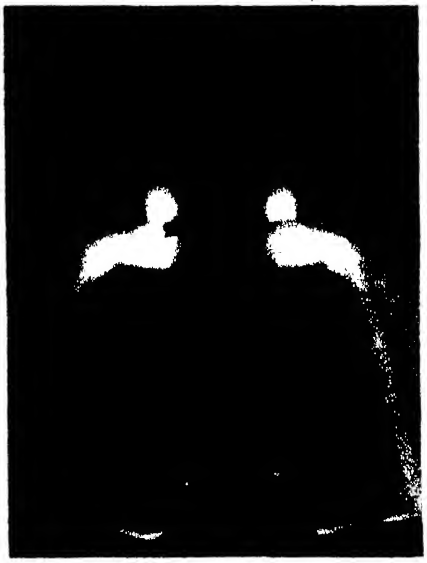
Light Patterns

The most graphic proof available that pictures are made of light and shade are examples of the type illustrated here. Cramped for space one day when projecting color slides, we backed the projector, an Eastman Model 2, against a wall, and noticed that the light coming through the various openings in the back of the projector produced an odd pattern on the wall. Convinced long ago that what the eye can see, the camera can photograph, we set up a camera on a tripod and made a time exposure of several minutes.

To make the most of the occasion, we made sure that no other lights were on to wash out the design. The best symmetry of the "eyes" and other features was obtained by pulling the slide holder out as if in position to project a slide. With only half the slide space in place, the design lacked symmetry, and this was essential to get the most convincing result. Both the image and the image producer are shown in one of the pictures, with the crinkle of the wall adding somewhat to the effect.

In an effort to make the most of our discovery, we tried setting the projector up at various angles with relation to the wall, finally hitting on one that produced the second result shown. This we obtained by standing the projector on its "face," that is, lens on table instead of the normal position. In this instance, we wanted to shield the projector so that it would show merely as a dark mass.

First attempt



Projector shielded

A sheet of black cardboard did the trick. Probably we have not as yet exhausted the possibilities, but here are two for what they are worth.

Try it with your own projector or other similar apparatus. Provide a white or light-toned wall, and make a few experiments. Shoot what looks reasonable. It will "come out" if you give it enough time. If there is enough light to use an exposure meter, read the darkest light portions you can and then double or quadruple the time. The brightest portions will be dense anyway and since, in most instances, the best results will be obtained only if the weaker tones are also recorded, it is better to over-expose the strongest reflections than to under-expose, and thereby lose, the weaker tones.

Soft Colors, Not Primaries

Just because the three-color process is concerned with the three primary colors is no reason for choosing these colors when selecting an arrangement for color photography. These colors usually are too brilliant for the best color results. More pleasing effects can be achieved by picking the softer colors and thereby avoiding harsh, candied results.

Stock Hypo

Most amateur workers habitually make up a stock of the regular acid-hardening hypo solution and use it on both film and paper. There are occasions, however, when you must use plain hypo, as when toning, making up a reducing formula, and so on. For negatives the acid-hardening formula is advisable, particularly in warm weather, and prints intended for ferrotyping should also be fixed in this bath. However, if you make up a stock of plain hypo—one part hypo to four parts water—the acid or hardener, or both, can be added as required. For toning prints, ¾ of an ounce of sodium bisulfite is added to a quart of plain hypo. A

Over $1100 in Prizes
36 Chances to Win

Sixth Annual
Scientific American
AMATEUR PHOTOGRAPHY CONTEST

POPULARITY of the divisional method of judging photographs in the Scientific American Annual Contests, as determined by the enthusiastic response in past years, has been so great that the method is once more being used for the Sixth Annual Contest. In each of the divisions listed below there will be awarded seven major prizes and five honorable mention awards, a total of 36 prizes in all.

Please read the rules carefully and abide by them. Note particularly Rule 6, under which any contestant may enter a total of six prints, but no more than two in any single division.

Divisions In Which Prints May Be Entered

Division 1. Human interest, including camera studies of people, animals and so on. Portraits will be grouped in this division.

Division 2. Landscapes, including all scenic views, sea scapes, and so on.

Division 3. Action, including all types of photographs in which action is the predominating feature.

THE PRIZES

1st. Three $125 LONGINES, Coronation Model, Solid Gold, Men's Wrist Watches.

2nd. Three $90 LONGINES, Presentation Model, Solid Gold, Men's Wrist Watches.

3rd. Three International Marketing Corporation PHOTRIX "22" Enlargers, complete, less lens. (List price $54.)

4th. Three Burleigh Brooks FOTH-DERBY Cameras, with built-in coupled range finders. (List price $34.75.)

5th. Three WESTON No. 715 Exposure Meters. (List price $24.)

6th. Three ABBEY Vimo Flash Guns. (List price $13.75.)

7th. Three Raygram LEE Timers. (List price $12.50.)

Five Honorable Mention Awards, each to be a new or renewal subscription to Scientific American for one year.

Address all Entries to

Photograph Contest Editor, Scientific American
24 West 40th Street New York, N. Y.

Rules of the Contest

1. The groups will be judged independently on the basis of pictorial appeal and technical excellence. The decision of the judges will be final. In case of a tie for any prize, duplicate prizes will be awarded to the tying contestants.

2. Prints must not be smaller than 5 by 7 or larger than 11 by 14 inches. *All prints must be mounted, otherwise* they will be returned immediately.

3. Photographs must be packed properly to protect them during transportation.

4. Non-winning entries will be returned only if sufficient postage is included when the prints are submitted.

5. Each entry *must* have the following data written on the back of the mount: Name and address of contestant, type of camera, and film, enlarger, and paper used.

6. Contestants may submit no more than two prints in each group, but may enter any or all groups. In no case, however, will more than one award be given to any individual contestant.

7. Prints must be in black and white or monotone. Color photographs are not eligible.

8. Prize-winning photographs will become the property of Scientific American, to be used in any manner at the discretion of the publisher.

9. Scientific American reserves the right to purchase, at regular rates, any non-winning entry.

10. No entries will be considered from professional photographers.

11. All entries in this contest must be in the hands of the judges by December 1, 1941. Results will be announced in our issue dated February, 1942.

12. The contest is open to all residents of the Western Hemisphere who are not in the employ of Scientific American.

13. In fairness to all contestants, failure to comply with any of the above rules will result in automatic disqualification.

THE JUDGES:

McClelland Barclay
Artist

Ivan Dmitri
Artist and photographer

T. J. Maloney
Editor of U. S. Camera

Robert Yarnall Richie
Photographer

stock acid hardener may be purchased ready prepared, or can be made up as follows, and kept in a separate bottle to be added, in the proportion of one part stock hardener to four parts stock hypo, as occasion demands:

Eastman Stock Hardener (F-1a)

Water (about 125°F.)	56 ounces
Sodium Sulfite, desiccated	8 ounces
Acetic Acid (28%)	24 fluid ounces
Potassium Alum	8 ounces
Cold water to make	1 gallon

Dissolve the sulfite completely before adding the acetic acid; add potassium alum with constant stirring. When alum is dissolved entirely, add cold water to make up volume.

Rapid Processing

A FILM processing technique that makes it possible to produce a dry negative ready for printing in about 10 minutes, is published in a leaflet issued by Wabash and combines a new rapid processing method announced by Agfa with the new Birdseye Sealed-Silver Heat Lamps. Five steps are involved:

1. A rapid working two-solution developer:

   Solution No. 1

Metol, or equivalent	½ oz. 80 gr.
Sodium Sulfite	4 ozs.
Hydroquinone	1¼ ozs. 30 gr.
Water to make	1 gallon

   Solution No. 2

Sodium Carbonate (monohydrated)	13½ ozs.
Water to make	1 gallon

2. A five-second short-stop bath (1½ ozs. 28% acetic acid in 32 ounces water).
3. Rapid fixation in concentrated hypo formula, such as Agfa's No. 201, made up as follows:

   Solution No. 1

Hot water (125°F.)	½ gallon
Hypo	3 pounds

   Solution No. 2

Hot water (125°F.)	20 ounces
Sodium Sulfite	2 ounces
Acetic Acid (28%)	6 ounces
Potassium Alum	2 ounces

   Add Solution No. 2 to No. 1 and then water to make one gallon.
4. A two-minute wash.
5. Speed-drying with infra-red heat lamps.

Because of the short processing time in each of the baths, the latter must be agitated continuously throughout the designated immersion period in order to avoid uneven results.

The negative is developed first in Solution No. 1 (70° F.) for one minute, followed, without rinsing, by a one-minute development in Solution No. 2. It is then agitated in the stop bath for five seconds, followed by fixation for 1½ minutes. Wash for 2 minutes in running water, but, for

permanence, it is advisable to wash later more thoroughly. Drying time takes two minutes if the following procedure is followed: Remove surface moisture by placing negative on clean ferrotype tin or sheet of glass and swab with rubber squeegee. Immerse in a tray of Agfa Rapid Drier for one minute, rocking the tray continuously. Squeegee the negative again and place in dry developing hanger suspended between two Birdseye Infra-Red Heat Lamps placed about two feet apart. An electric fan, set up behind the negative, is turned on first to send the flow of air across the path of the infra-red rays on each side of the film, as described in these columns in July.

Further details are available in the leaflet.

Low Viewpoint

EVEN so simple a subject as that shown in the illustration can be given dramatic effect by the choice of a low viewpoint. The camera was about six inches from the ground, a rusty tin can serving as tripod. Stop *f*/32 was used in order to get sharp

"Low Tide"

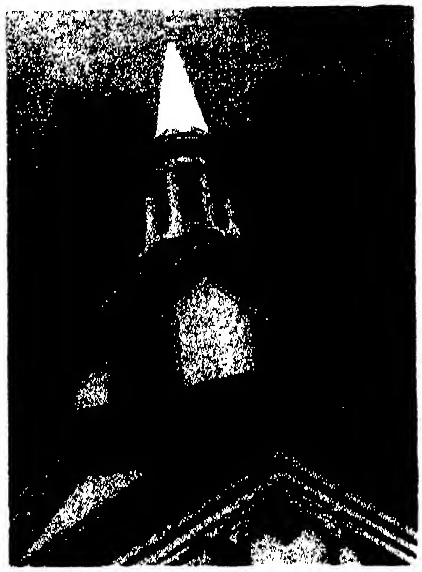
focus all the way through. We chose to feature the reflection in this particular shot, although a fine result may also be achieved by featuring the sky, the mast of the boat running diagonally across a medium-toned sky. In that case the boat and the water would occupy less than a third of the picture. The viewpoint would be the same.

Hands in the Picture

IT IS always better not to instruct the subject as to where to place the hands, but rather to suggest a pose and let the hands place themselves naturally. However, in many instances, hands do get into positions where they look awkward, even though unposed, and something must be done to bring them into line. Here are a few suggestions. Have the hands close to the body. One hand in half shadow will help to make it less prominent. Resting the head on one hand, with the hand on the shadow side of the face, is a useful idea. When the full hand is shown, bending or folding some of the fingers will help. Posing the hands flat with the fingers drawn up to the second joint suggest amputation; obviously this should be avoided.

Church Spires

A WHITE church against a darkish sky has a perennial attraction for the camera fan. Its sheer simplicity, the beautiful contrast, and the atmosphere of peacefulness surrounding



Christopher Wren spire

the scene, all contribute to one of the most attractive subjects we have in photography. The usual method is to shoot from a distant vantage point in order to include the entire church and make it stand straight. When the limitations of the camera make it necessary to tilt the camera, we usually straighten the image on a tilted easel under the enlarger. Sometimes, however, a more impressive result is obtained by coming close and shooting up at the church at an angle, as in the case illustrated. Make sure your stop is small enough—*f*/32 in this case—to bring everything into sharpness. A tree branch will help to frame the picture and fill space.

Removing Scum

SCUM streaks, particularly on dry negatives, will print out on paper and require much laborious spotting. Eliminate the scum and you save yourself this trouble. An effective method is to boil a pint of water, cool it, then add ½ ounce of hydrochloric acid. The wet or dry negative is immersed in this solution and allowed to remain for one minute. During this time it will take on a deep blue color, which may be removed by immersing in hypo for several minutes, then washing. Some of the blue will still

remain after washing is finished, but upon drying the blue will have entirely disappeared, together with the offending scum, leaving a clean negative.

Using Filter Holders

ONE of the most attractive conveniences recently put on the market, especially because it is low-priced, is the Varigram filter holder. The projecting tab at one corner makes it easy enough to hold under the lens for the required exposure time, but most workers will find a method of attaching it to the enlarger in some way in order to leave their hands free for dodging and other manipulations. One suggestion is shown in the illustration. A small spring clip has been attached to one corner of the lens platform. Because the filter holder is so light, being made of cardboard, the single clip keeps the holder firmly in place.

A clip holds it

Bottle Caps

PREPARED developing and other solutions are sometimes bottled with a metal cap. With use, the metal becomes rusty and, besides being unsightly, the cap is hard to screw off. In any event, the rust cannot be too good for the efficiency of the solution itself. Some manufacturers now use Bakelite caps and these are ideal for the purpose. Standard Bakelite caps for standard brown bottles are now available at about a nickel apiece. A good idea is to stock up on a few of these and replace the metal caps with the Bakelite ones.

Unfixed Film Edges

IN DEVELOPMENT of roll film by tank, workers find that the edge of the film frequently comes out of the fixing tank unfixed. An effective way to get rid of these whitish streaks along the edges is to agitate the fixing tank for a couple of minutes when fixing is started and again several minutes later. If you follow this procedure, you won't have this trouble again. What happens is that the whole film is shaken free of contact with the developing reel with the result that the edges as well as the negative images themselves, fix out.

Polarize Your Color Shots

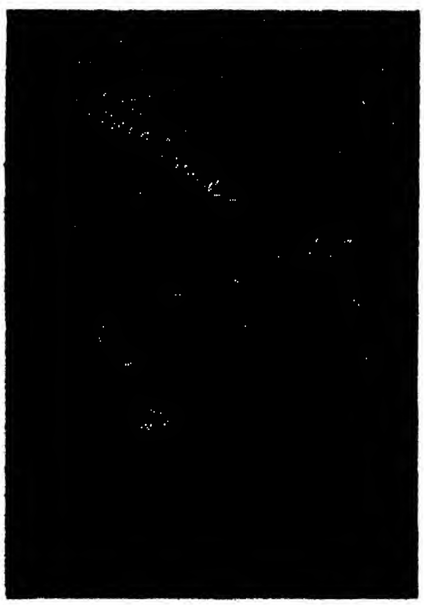
IF YOU have never tried using a Polaroid screen when shooting color film, you have a grand treat in store. A blue sky looks really something very special when darkened by a Polaroid screen placed over the regular lens. Such dramatic effects in black and white are always extremely attractive; when obtained with color, the results are even more satisfying. Use one stop larger than ordinarily to compensate.

Movie Makers and Thespians

SEEMS to us there's nothing to beat a combination of a movie-making group and an amateur players' club. The two were just made for each other. If a still-camera club offers nothing for movie fans, a group of the latter may well combine with a thespian group. Thus, you will have technicians and players, just as in Hollywood. Naturally, the method of production will have to be slanted movie-wise. At the start, it will probably be necessary to produce only silent movies; later on, with financial improvement, talkies may be inaugurated. New outfits of this type recently placed on the market have made the cost not so prohibitive as it used to be.

Composing Vacation Pictures

GROUPINGS such as the one shown in the accompanying illustration by Albert Greenfield, New York City, are not easy to compose. But the watchful and alert photographer will frequently be rewarded for his patience



"Greetings!"

if he will hold his fire until the several members of the group have composed themselves into some sort of agreeable composition. As the individuals move about and look this way and that, the worker watches his chance and shoots when he can spot at least one dominant point of interest in the group. Here Mr. Greenfield, en route to Haiti, found his point of main interest in the standing, white-shirted, grinning figure.

Add Color Lexicon

THE deeper we get into color photography, the more new words and new ways of photographic speech we shall encounter as time goes on. Recently, a color man referred to a particular one-shot color camera as having a speed of Weston so-and-so. A puzzled look brought the explanation that the camera was loaded with a certain film which was recommended for use in that camera. Although the black-and-white speed of the film was much higher, this speed was brought down to the stated speed because of the additional exposure time required by the use of filters in the camera.

Smudges on Prints

IF YOU get a smudge or dirty streak on a print and find that it stubbornly refuses to disappear, despite your efforts with fingers or otherwise, try this. Wet a viscose sponge, then drain it of water by squeezing. The moist, but not wet, sponge can then be passed over the spots on the print. This is particularly effective with such tricky surfaces as Artona Rapid, which take offense at the usual treatment and show worse spots than before. This particular surface attracts lint very readily; the sponge trick gets rid of lint quickly and effectively.

Multiple Filters

A GROUP of photographic experts, sitting in on an "Information, Please" session at a recent meeting, were stumped by this question: "If you had to use three filters at the same time, having a factor of 2, 3, and 4, respectively, what exposure factor would you use?" The incorrect answer was 9; the correct one was 24. The factors are multiplied, not added.

Lighting Governs Exposure

WHEN using an exposure meter from the position of the camera, normal timing should be used for most subjects; that is, when the lighting is fairly graduated, and there is a fair balance of light in both high-lighted and shadow areas. On the other hand, when the lighting is flat, it is advisable to use half this exposure time because there are no shadows to worry about and it is therefore not necessary to allow for them, which the normal reading does. With subjects having deep shadows, however, and strong high-lights, double the normal reading to make sure the shadow detail will be recorded.

Minimum Distance Work

"FLEURETTE" (goat to you) had an intense curiosity for the Rolleiflex camera with which we were following her around in an attempt

"Fleurette"

to get a close-up shot of her head. The lens panel was racked all the way out, focusing being confined to moving the camera toward the subject until the image became sharp. Every time we moved the camera forward, so did Fleurette. After a few attempts, we finally got the result you see, fully sharp from nose to horns, at *f*/8. The three-quarter angle makes it possible to avoid distortion.

The Judges

COMPLETE rules of the Sixth Annual Scientific American Photography Contest are published again on page 98 of this issue.

The judges who will decide the fate of the prints entered in this contest are McClelland Barclay, well-known magazine illustrator, Ivan Dmitri, whose work in color photography has been widely published, T. J. Maloney, Editor of *U. S. Camera*, and Robert Yarnall Richie, many of whose photographs have been used in Scientific American and other magazines.

• • •

WHAT'S NEW

In Photographic Equipment

CINEMASTER DUO 8MM ($27.50 and up): Uses standard double 8mm film, color or black and white, as well as Univex straight-eight film. Features: combined exposure meter and optical view finder, built-in with etched masks for telephoto lenses; the extinction type exposure meter is operated by a dial on side of the camera; high parallax correction due to small distance between view-finder and lenses; three speeds—16,

24, 32 frames per second; new type exposure calculator; continuous running—starting button can be locked in taking position; interchangeable lenses include regular Univar Anastigmat $f/3.5$, $f/2.7$ or $f/1.9$ in micrometer focusing mount, plus supplementary telephoto lenses $f/3.5$ in 1"

The new Cinemaster Duo 8mm camera that uses either standard double 8 mm or straight-eight film

and 1½" focal lengths; quick, easy loading; footage counter automatically reset for each new loading; special take-up sprocket; improved governor maintains high uniformity of speed during film run; powerful spring motor runs six feet of film at each winding, sufficient for three average scenes; focal plane shutter—exposure time at 16 frames per second, 1/30 of a second.

BOOL'S AUTOMATIC SPLICER: Joins 8mm, 9½mm or 16mm film. Made of steel, heavily plated in satin chrome. Splicer mounted on skid-proof, warp-proof, ebony-finished wood base. Splices said to leave neither white or black line (emulsion neither overlaps or separates). Hardened steel file, double-edged, scrapes emulsion evenly. Spring in spindle aids operation. Grooves in cutting leaves catch surplus cement.

PRINCETON PHOTO SWITCHBOARD ($6.95): For control of several light sources. One light can automatically turn on when another is switched off. Unit serves as high-low control for Photofloods; can switch light on and off from camera position. Enables making multiple flash pictures, or up to four flash shots in rapid succession when synchronizer is used; three open-shut flashes in succession without synchronizer.

MINILUM VIEWER ($1.50): Vest-pocket-size viewer for Kodachrome slides. Fitted with battery and electric bulb. Bulb lights up, illuminating slide, when side of case is pressed. Made of all metal; contains ground glass for diffusion of light.

CROWN MULTIFLASH CONTROL UNIT ($35): Designed for use with all flash synchronizers. Features: fires from 1 to 40 bulbs simultaneously, either with synchronizer or open-shut flash; uses 110-volt regular house current; as portable equipment where house current not available, uses high-voltage dry cells such as used in portable radios; neon circuit tester built into panel, allowing user to test line and wiring; may be used with electromagnetic, mechanical, and manual guns, as well as open-shut; may be fired by remote control; power switch has own signal light which can be read at distance; weighs 3½ pounds complete; measures 7½ by 4½ by 4 inches.

SM BULB FITS KALART COMPAK: New SM (Mazda Speed Midget) bulb can be used with Kalart Compak Passive Speed Flash, gun makers announce, who add, Kalart Compak "is

the only complete flash synchronizer having a reflector designed for midget bulbs by lighting engineers." Compak also uses Mazda No. 5 and No. 6 and Wabash Press 25.

"OUR FIRST LINE OF DEFENSE": Official Films presentation, produced in co-operation with the United States Navy. Home movie production available in five standard lengths in 8mm and 16mm. Shows the various Navy units in action—destroyers, cruisers, dreadnaughts, torpedo planes, aircraft carriers, fighting planes.

TEXTILEX QUICK FILM DRYER (40 cents per tube—for roll film; 30 cents per envelope—for cut film): Insoluble, lintless paper for quick drying of negatives by absorption of surface moisture. Designed to produce dry negatives free of dust, scum, and smudge. Available in rolls of five strips for drying roll film, and in sheets—8½ by 10½ inches—for cut film.

R.H.S. ELECTRONIC EXPOSURE METER ($10.95): Features removable dials for all film ratings. Permanently attached universal film-speed dial supplemented by three removable dials each for different combinations of daylight and artificial light film ratings. Supplementary dials provide specifically for eight popular films named on dials or other films not named on dials but having same ratings. Meter reads directly on needle dial in "f" stops for any film having rating of 32 when using 1/25 of a second shutter speed. Meter comes complete with three removable dials, complete instructions and genuine leather eveready case.

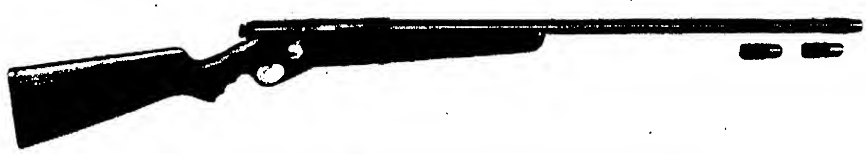
YOUR FIREARMS and FISHING TACKLE

Conducted by A. D. RATHBONE, IV

INTEREST IN FIREARMS *is traditional with American men; fishing tackle is a requisite of one of the world's oldest occupations. Scientific development of guns and tackle, in the use of which millions yearly find sport and recreation, fathers this monthly department which welcomes correspondence from readers.*

Three Little Gadgets

WHEN you look at the gun illustrated below, note particularly the two little gadgets shown under the barrel and the similar gadget on the end of the barrel. The gun itself is a 20-gage, bolt-action, repeating shotgun with detachable clip of two-shot capacity—and a third in the chamber, if desired. But the three little gadgets comprise the crux of this story, for they are machined choke tubes, easily and quickly interchangeable, thereby producing a three-shot scattergun with full choke, modified choke, or improved cylinder choke, as may be desired. And by shooting the gun without any tube attached, you get a true cylinder which, although offering no control over the pattern, is still preferred by some shooters.



Mossberg's Model 85 D, with three choke tubes

The novelty and practical ingenuity of this application of varied chokes to one gun is—in case you haven't already surmised—another of those amazing Mossberg productions. Of recent years it has seemed as though the gun world has barely had time to assimilate one Mossberg innovation before another equally unique and constructive development has emanated from that busy plant. The simplicity of this multi-choked shotgun idea is one of its cardinal virtues. If your shooting calls for maximum effective range, simply screw on the full choke tube, while if more scatter and less distance are desired, remove the first and attach either the modified or improved cylinder tube. It's all as simple as that, takes but a couple of minutes at the most, and, best of all, the entire outfit—gun and three tubes—can be owned for less than $15.

As to patterns, the tubes are machined and choked to produce the following averages:

Full choke	70 percent
Modified choke	60 percent
Improved cylinder	50 percent
Cylinder	40 percent

You'll note that this gun, known as Model 85D, carries the customary Mossberg streamlined design. It is 45½ inches long, weighs 6¼ pounds, is chambered for all 2½ and 2¾-inch factory-loaded shells. It has a molded butt plate, finger grooves in grip, flush type take-down screw, self-cocking action on the upstroke of the bolt, and is equipped with a positive safety, double-locking bolt, and closed-top receiver. Barrel is 25 inches long, tapered, of blued steel and is proof-tested.

A companion gun to Model 85D is Model 83D, a four-shot, .410 bore repeater, also bolt-action, with a length of 44½ inches, a weight of 5½ pounds, and a 23-inch tapered, blued-steel, proof-tested barrel. The .410 is priced at slightly over $12, is equipped with two choke tubes, full and modified, but can also be shot in cylinder bore without any tube attached. Both guns have an exceptionally comfortable "feel," both, because of Mossberg's novel adaptation of the choke tube idea, are suited for field or skeet shooting, and both are illustrated and described in Mossberg's 1941 catalog, a copy of which we'll be glad to send you.

Kink

CAMPING, fishing, and hunting kinks aren't always a result of logical thought sequence; usually they just happen, like the one illustrated below. Despite the generous proportions of our tackle box, plugs per-

The tackle stick

sisted in involving themselves in pestiferous entangling alliances. Also, it doesn't improve one's tackle container to continually put dripping-wet lures into the little compartments. Lastly, it's a long stretch from either bow or stern seat of an 18-foot canoe to the tackle box, placed amidships. So, we cut a stick the proper length, lashed it to the gunwales just abaft the bow seat for the convenience of the-lady-who-catches-more-fish-than-we-do, and draped a goodly selection of plugs and bugs thereon. When not fishing, the tackle stick is untied and reposes on two crotched poles, driven into the ground near the camp.

Book of the Moment

CAPTAIN CHARLES ASKINS, JR., who ably edits the firearms department of the magazine *Outdoors*, has just published his newest book, "The Art of Handgun Shooting," and if anyone should know whereof he speaks in the realm of pistoleers, it's Captain Askins. He has won 472 medals and 126 trophies in handgun competition, annually burns up approximately 34,000 rounds of ammunition in match and exhibition shooting, and he's still going strong. The new book was written both for beginner and expert, is packed with thoroughly practical advice and suggestions, and, in these national defense days, it will prove a necessity to any who shoot pistols.

Use the Right Cartridge

FREQUENTLY, when science assists the firearms industry to better its products, that forward step entails necessity of a proportionate increase of knowledge on the part of gun owners to utilize the improved firearms properly and safely. An old, yet still imperative example of this axiom is the graduation in shotgun manufacture from Damascus, or twist steel barrels to barrels strong enough to safely withstand the strength of today's heavier shotgun loads. Ever since man first began making guns, he has endeavored not only to increase accuracy, but also to achieve greater firing power, and even though gage of shotgun or caliber of rifle remains unchanged, amplification of the powder load in modern shell or cartridge often makes it dangerous practice to use today's ammunition in guns of a generation ago.

That this holds true in the handgun field as well as with the shotguns and rifles is attested to by C. V. Bassett, of Smith and Wesson, Inc., who writes: "I've noticed that several writers have been cautioning sportsmen against use of modern shotgun loads in old Damascus steel-barreled guns. It would be a grand thing if handgun shooters could likewise be cautioned against use of loads other than those designed for their arms. All revolver manufacturers have huge numbers of old models out which were made before the days of heat-treated cylinders and such, and which, nevertheless, will chamber modern, high-speed loads. Frankly, these are a source of considerable expense and many headaches to the manufacturers. It is not uncommon for a fellow to inject a .38/44 or .38 Special High Speed cartridge into a gun 40 years old and blow out a cylinder or warp the frame, after which he returns it to the company with a complaint that his nice, old gun 'must have been defective.' Usually the manufacturer fixes it all up for him and cautions him against the use of high-speed loads thereafter. However, the whole procedure is something like locking the barn after the steed is stolen."

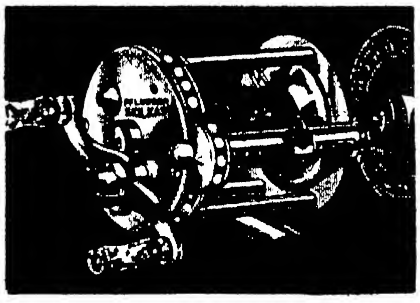
Incidentally, Cy Bassett has authored a constructive folder entitled, "Helpful Hints." Want one?

• • •

POT SHOTS

At Things New

ENTERPRISE MANUFACTURING COMPANY, makers of Pflueger fishing tackle, say thumbs are out! Leave 'em home, if you like, for all the value they'll be when you're using one of their new mechanical thumbing reels in your bait casting this summer. Pflueger's "Skilkast" has a mechanical thumber built into the back plate which does away with all need for thumbing after the cast is started. It is adjustable with micro-precision to suit the line and lures used, operates only while line is running out, and makes distance casts simpler and easier without tendency to over-run or backlash. Equipped with light-weight aluminum spool and cork arbor cemented in balance, "Skilkast" has replaceable bearings for double thread shaft, thus permitting level wind parts to be removed without disturbing housing, and is recessed at each end to make possible the wide line guide and still permit line to be laid on full width of spool. Since "Skilkast" came into our angling existence, we've conserved the skin on one good thumb, refrained from being, at times, an irascible fishing companion, and, due to absence of back-lashes, have actually had more time to devote to the big ones. Want a "Skilkast" folder?



Pfleuger's "Skilkast"

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

If a mechanism does its intended work, and satisfies its owner, it is a success. A fine telescope drive, with gears and fancy trimmings (machine work), is a pretty thing to have, but also is complex and costly. A good telescope drive (Figure 1), innocent of sex appeal but which gits thar just the same and is simple and inexpensive, has been devised by C. S. Walton, a candy manufacturer, 5975 W. 44th Ave., Wheatridge (Denver suburb), Colo. A neighbor of his, Anton Bohm, gravestone manufacturer, 6815 W. 29th Ave., Denver, on seeing Walton's drive, made up the variation of it shown in Figure 2.

Figure 1 does not show much detail, but there isn't much essential detail to the working principle—a fact which is all in its favor. Horizontally across the pedestal at about waist height there is a 10-32 thread-rod about 15" long. A Hansen 600 Synchron motor, made by the Hansen Mfg. Co., Princeton, Ind., containing a gear train that reduces its speed to 2 r.p.m., is direct-connected to the right end of this rod through a simple, home-made clutch. A traveler moves on the thread-rod toward the left, and a ¼" strip of 0.005" shim brass is

Figure 1: **The Walton drive**

connected to this traveler and runs around the nearer side of the large pulley, up over it and down to an idler and a counterweight hung below. The drive from this pulley through to the tube is by way of one of the two rolls on which the big split ring of the mounting rotates, the pulley shown being attached to the end of the stub shaft of that roll. The working principle may, however, be adapted to other types of mounting.

"So there you have it," Walton writes. "Motor to thread-rod; traveler to brass strip to pulley; pulley to split ring; split ring to telescope." When the traveler has crept the length of the thread-rod, returning it to the beginning is a simple trick.

And now for a little refinement that affords small manual adjustments, as in guiding. The left end of the thread-rod thrusts or butts square against the right end of another thread-rod. Now, if this second thread-rod is rotated in its own fixed screw, the effect will be either to add to or to subtract from the total motion of the telescope tube. This feature works as follows: On the nearer end of the second thread-rod is a simple pulley. A foot or so below this on the nearer post is another little Hansen motor belted to that pulley. Seen thrown loosely around the horseshoe, in the photograph, is a heavy wire. This is the flexible, distant, hand control for slowing or speeding the drive by operating that motor at will. A double switch, made from spring clothes-pins and held in the hand, does the trick. To advance the tube slightly, you give the little motor an electric kick. To retard it, you cut the current of the main motor. "No gears to throw in or out, no clamps, no nothing," Walton says. You push the telescope to a star and the drive takes charge from there. He sent some photographs—Pleiades, comet, nebula—made with this guiding control and these speak well for the whole equipment, including the 12" mirror of the telescope.

Walton's neighbor, Bohm, mentioned above, took one look at the drive and ran home to cook up one for himself (Figure 2). It varies a little from Walton's; few amateurs like to copy slavishly. It has no micro-adjusting feature for guiding, hence it is only for visual use. Main motor at right (cost $2) drives screw-rod (cost 5 cents) at 2 r.p.m. through simple clutch. Since the screw-rod has 32 threads per inch, the nut traveler which tows the telescope tube along moves toward the left at the rate of 1" per 16 minutes, and Bohm points out that it is a matter of simple arithmetic to find how far out from the center of the polar axis to attach the little rod that connects the traveler to the lever that drives the tube; final adjustment may then be made exact if there is a slotted hole in this lever. Bohm also has a friction connection between his lever and polar axis, this being the equivalent of a friction disk drive, and this permits quick large shifts while the motor is running.

The weight seen pendant in Figure 2 pulls on a silk fishline running over two small pulleys and to the traveler. This helps the motor and holds the rod against the thrust bearing near the extreme left. What at first appears to be a flywheel, at the left, is simply the convenient handle of an

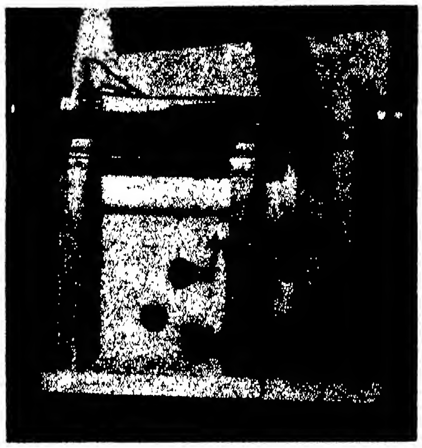


Figure 2: **Bohm's modification**

end-thrust screw for the screw plug which takes the end-thrust of the thread-rod.

After about an hour's running the traveler reaches the end of the thread-rod (what it actually reaches just before that, however, is a little limit switch which shuts off the motor in case the observer forgets, thus forestalling a jam). At the end of the hour's run the handwheel is unscrewed and removed, the thread-rod slid far enough to the left to disengage the "clutch" connection at the right. Then, by means of the little crank handle visible below, the traveler is spun back to the starting point in a hurry, ready for the next hour's driving. It sounds complicated, but actually it all works quickly.

Bohm says that, with this drive, it is possible to keep an object in the center of the field with a high-powered eyepiece for the hour's run on the thread-rod.

In no place in "A.T.M.," unfortunately, is it clearly pointed out that the handle to be attached to the mirror disk for grinding and polishing (unless the worker prefers to omit it entirely, as some do, and simply take hold of the disk itself) is not intended to be grasped in the hand *in the typical manner* of a handle but is rather a convenient centering device. There is evidence that some beginners do, however, grasp it in one hand, full length, and tightly, throughout grinding and polishing. The result often is a badly turned edge since the pushing effort is usually too high, also since it is practically impossible not to introduce undesirable lateral force components when working this way. (You can pick up a cat by the tail, close to the body, and swing it without a protest, provided you don't bend the tail in any part of the swing, but the cat will tell you from experience that, when you say you don't, you only think you don't.)

Probably the whole trouble into which many beginners are misled derives from the unfortunate use of the term "handle." In "A.T.M.A.," Everest discusses the effect of pressure applied too high and shows one excellent form of centering device: a 4½" by 1½" wooden disk, *for working*, carries on its top a 4" by 1⅛" handle *for lifting* the mirror. This keeps the working pressure low.

STELLAFANE convention, Springfield, Vermont, Saturday, August 2.

SPHEROMETERS for measuring sagitta, or depth of curvature, $r^2/2R$, of a mirror, or the curvature of a lens, may be made from a ten-cent-store

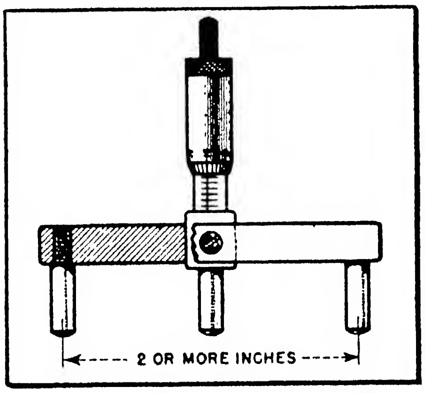


Figure 3: **Taylor's spherometer**

micrometer caliper, as shown in Figure 3, which is redrawn from a sketch submitted by D. Everett Taylor, 192 Prospect St., Willimantic, Conn. Saw off the anvil and frame part and substitute the two arms and legs shown. And don't forget that the $r^2/2R$ now employs the r of the spherometer, not that of the mirror!

WHILE nearly all amateur telescope makers test their mirrors at the center of curvature, nearly all professionals test at the focus, with a flat as an accessory; and it is a rather amusing commentary that, even granting the superiority of the test at the focus, some professionals have tested in this manner for so many years that they have come to think, and one of them even to say, that it isn't even possible to test at the center of curvature. It does require a little more mental effort, it is true. However, after one has provided the set-up, the test at the focus is a big convenience, and there are other considerations: more rigorous, for example.

William Buchele, 2832 Sagamore Road, Toledo, O., sends us the photographs shown in Figure 4 and says: "This is a gadget for testing at the focus with a flat. Light source is a 100-watt projection lamp. Its housing has cooling flanges to prevent the lamp from overheating. A thin silvered diagonal reflects light through a hole in the flat, it returns from the glass under test, and passes through the diagonal, thus permitting the

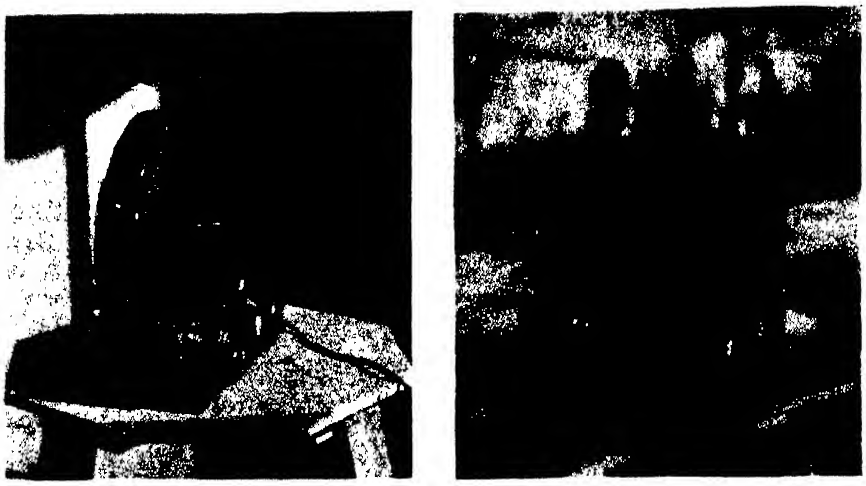


Figure 4: **Two aspects of Buchele's test-at-focus gadget**

light source and the eye to be in the same train simultaneously. The gadget has a micrometer screw feed. The dark upright strip in the center is a graduated system of fine and coarse pinholes and slits. There is also an eyepiece, knife-edge and Ronchi grating holder, with lateral rack and pinion feed."

TEST for short focus mirrors, used by telescope-making members of the Detroit Astronomical Society and reported by Eugene G. Brown, 4404 Vermont Ave., Detroit, Mich., is shown in Figure 5. At *b* is the light-source, *c* the perforated mirror under test, *d* a paraboloidal test mirror, *e* the knife-edge or Ronchi grating. "The image produced," Brown writes, "is identical with that produced by a sphere under the Foucault test. We therefore work to this flat image and we interpret our high and low zones exactly the same as we would with the Foucault test.

"Such a test is necessary to produce a good figure in an extremely short focus, such as $f/2$ or $f/2.5$ (unless we use the Gaviola test)," Brown continues, referring to the fact, still not sensed by all, though Ellison explains it in "A.T.M.," that while you usually can get by with a visual estimate of the smoothness of sweep of the curve of a medium or long focus mirror between inside and edge zones, provided only the latter are correct, you cannot safely depend on this on a short focus mirror. Even when the intervening shadows then look smooth, they are so dark that they may easily mask local irregularities which you therefore may let go in ignorance of their existence.

Brown adds that Ralph Tozer of Detroit is the first there who used the test described above. He points out that there are other applications and variations of this test. For example, if a point-source of light is placed at the focus of the paraboloid, a parallel beam is projected from the latter, and this artificial star may be used to test any astronomical instrument, refractor, reflector, or camera.

Another wrinkle, suggested and used by C. M. Davenport, of the Detroiters, is piped-in light for this test. The object *ab* is a bent rod of solid $\frac{1}{4}$" or $\frac{3}{8}$" Lucite, a transparent plastic [obtainable from E. I. duPont de Nemours, Inc., Plastics Department, Arlington, New Jersey and bent in very hot water or oil.—*Ed.*]. Instead of placing a primary light-source at *b*, where its heat would interfere with the test, this is at *a*, well out of the works, and the light follows through the Lucite to *b*. The end of the Lucite rod may either

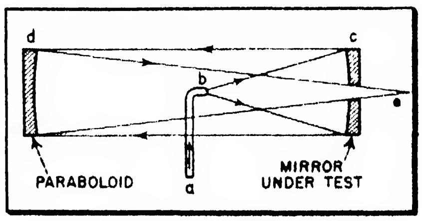


Figure 5: **The Detroit test**

be left straight but beveled, or bent, but in either case tinfoil is wrapped around its end and touched with a finely pointed needle ("A.T.M.A.," page 89).

W. S. Bohlman, 823 West Street, Wilmington, Delaware, has similarly used Lucite to pipe light from a removed primary source to the pinhole, thus avoiding a burned nose, also permitting the pinhole to be placed close to knife-edge. He used the Lucite rod from a common throat light such as those commonly on sale at drug stores. This served as well behind a Ronchi grating as in place of the usual pinhole. He suggests a piece of Lucite bent to 90°, its end covered with foil having a pinhole, for testing secondary mirrors.

The above item was shown to Russell W. Porter, who replied that this test has been used at the Optical Shops of the California Institute of Technology in testing the 48" Schmidt correcting plate. However, it apparently was not published, so credit goes to the Detroit amateurs who hit on it independently and offered it for publication. That's the good old rule throughout the world of science.

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with a list of available titles, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for.

HOW TO BE AN ENGINEER

By Fred D. McHugh

COUNSEL for would-be engineers. That high-school youth who is so mechanical—does that mean he should try for engineering? Or that boy who isn't—does that exclude him? Traditional beliefs about the requirements for the engineering vocation, also about its real nature, are not extremely accurate and thus many youths acquire incorrect ideas about both. They study engineering, graduate, and too often discover—disillusionment. The special aptitudes a youth should have for engineering are dwelt on at length in this chatty book of sage advice, and the real nature of the work in each branch of engineering is explained. To find out as much as it tells, a boy would have to talk with a whole score of engineers. This book should be kept in every high-school library. (187 pages, 5¼ by 8 inches, illustrated.)—$2.10 postpaid.—*A. G. I.*

48 MILLION HORSES

By Humphrey B. Neill

ELECTRICITY in the fields of Energy, Light, Comfort, Tele-Magic, Transportation, and Industry—that is, in its entire broad field—is the theme of this readable, non-technical story of what electricity is doing today. A romantic story, indeed; the author has fully sensed its romance as well as its significance. (241 pages, 6 by 9 inches, illustrated.)—$2.60 postpaid. —*A. G. I.*

FOOD ALLERGY

FITTING a diet specifically to the needs of one individual who has digestive upsets and suspects hidden food allergy, is something a doctor could do if the patient could afford to pay for all the time this would require, also for a long explanation. This little book, by a famous specialist, tells the patient in plain language how the individual diet may be worked out largely by himself and contains, at a fraction of the price of a single doctor's call, what he would say if only he had time. Editor-in-chief of the series of books, of which this is one (others deal with ulcer, colitis, gallstones, migraine, and more are to come) is Dr. Walter C. Alvarez, of the Mayo Clinic. (59 pages, 4½ by 7½ inches, unillustrated.)—$1.00 postpaid.—*A. G. I.*

THE ABC OF AVIATION

By Lieut. Col. Victor W. Pagé, U. S. Air Corps Reserve

THIS latest revised edition of a simplified guide to modern aircraft has been brought completely up to date. Included are descriptions and illustrations of the latest types of planes and aircraft power plants. The text is presented in such a manner as to be comprehensive to the beginner, yet sufficient detail is included to make the book of reference value to advanced students. (598 pages, 5½ x 8 inches, 285 drawings and photographs.)—$2.60 postpaid.—*A. P. P.*

PLAGUE ON US

By Geddes Smith

ABOUT epidemics, pestilences, and plagues of disease, past and present—the black death, yellow fever, Spanish influenza, pneumonia, tuberculosis, colds, malaria, and others. Also about contagion, infection, and a host of things pertaining to epidemiology and disease. A popular book yet rather more scientific and scholarly than most such; nevertheless it is written with charm and is never dull or pedantic. (365 pages, 6 by 9 inches, illustrated.)—$3.10 postpaid. —*A. G. I.*

THE GEESE FLY HIGH

By Florence Page Jaques

RIGHT now, while our geese are nesting in their breeding grounds in the lakes of the northland, is the time to enjoy this entrancing and in-

teresting story. The author and her talented husband, whose artistic pen has produced startlingly true-to-life illustrations, followed the ducks and geese from the Minnesota marshes to the swamp preserves of Louisiana. Their experiences, impressions, descriptions, wildlife observations, and illustrations combine to form a fascinating and educational odessy. (102 pages, 7½ by 10 inches, 50 excellent illustrations.) — $3.10 postpaid. — *A. D. R., IV.*

MAINTENANCE OF SHADE AND ORNAMENTAL TREES

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VALUABLE alike to the qualified tree expert and to the estate owner this authoritative volume, well written and interestingly presented by an outstanding pathologist, contains much new information in regard to the problems of tree growth and maintenance. Ably illustrated with photographs and line drawings, the first part of the volume is confined to a discussion of the normal tree and all phases of its care, while the second and by far the larger part is devoted to specific abnormalities of trees, alphabetically arranged by the name of the trees for quick reference. An extensive and carefully selected 15-page bibliography adds considerably to the value of the volume to the horticultural worker.—(422 pages, 6½ by 9½ inches, illustrated.)—$4.60 postpaid.—*C. F. G-C.*

WINGS OF VICTORY

By Ivor Halstaed

THIS is a magnificent story of the RAF in action. The book describes air warfare in France and the aerial war over Britain in graphic and interesting fashion. Then follow stories of personal adventure and exploits which make thrilling reading. The wonderful courage of the populace of London in meeting bombing attacks is exemplified by graphic and touching stories.. The book is of interest to all those who study military aeronautics or who are interested in military aeronautics and it will make a wide appeal to the general public following this air war over Britain with painful concern. (221 pages, 26 illustrations.)—$2.60 postpaid.—*A. K.*

AEROSPHERE FOR 1941

By Glenn D. Angle

THIS, the second annual edition, as complete as military and naval policy will permit, is a reference book that will prove indispensable to anyone interested in aviation from a professional or business point of view. To help solve the increasingly difficult problem of keeping abreast of airplane specifications, the book is

divided into four sections, devoted respectively to Modern Aircraft, Modern Aircraft Engines, Statistics, and a Buyer's Guide. Profusely illustrated, the information is accurate and well arranged. (948 pages, many illustrations.)—$10.00 (plus shipping charges, as book weighs nine pounds.) —*A. K.*

RADIO OPERATING QUESTIONS AND ANSWERS

By Arthur R. Nilson and J. L. Hornung

THE seventh edition of this standard technical review book covers the entire scope of the revised FCC license requirements. It is designed not as a text book but for use as a quick review of essential theory of pertinent mathematics and diagrams, and it covers a wider range in both the engineering and regulatory fields of radio communication than the previous editions. Approximately 1300 questions and answers, written concisely and with the greatest possible clarity, have been included. (415 pages, a number of diagrams, 5 by 8 inches.)—$2.60 postpaid.—*C. F. G-C.*

STRENGTH AND STRUCTURE OF THE EARTH

By R. A. Daly

MANY geologists believe the earth's strength below 40 to 60 miles is close to zero, increasing farther down, then decreasing again in the iron core. This fundamental problem of strength of the earth-shells reflects in turn on great, controversial major earth problems such as that of the earth's shape, the development of mountain chains, origin of continents, floodings and recessions of the sea, igneous action, and metamorphism. The complex theme of this book is the distribution of the Earth's strength by depth. (434 pages, 6 by 9 inches, 85 illustrations.)—$3.60 postpaid.—*A. G. I.*

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By Hanson W. Baldwin

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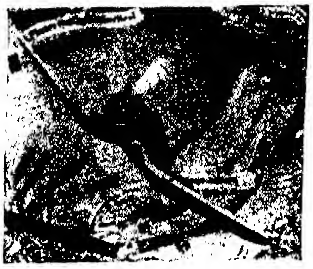

CONTROVERSY regarding the over-all fighting ability of American-designed warplanes thrives on mis-information. The true facts of the situation, as revealed by careful study of various data, are given in the article starting on page 119. Our cover illustration this month shows a Vought-Sikorsky F4U-1 shipboard fighter; artwork by F. R. Paul.

SCIENTIFIC AMERICAN

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NINETY-SEVENTH YEAR • ORSON D. MUNN, Editor

SEPTEMBER • 1941

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MORE PILOTS — FASTER

Every airplane produced for the air forces of the United States requires a pilot; there can be no argument about this obvious truism. Yet, while every effort is being made to increase speed of plane production—some types are now coming off assembly lines at the rate of one every two and a half hours—pilots are still being trained by time-honored methods that take many months to produce a finished flier. True enough, an accomplished military pilot must have experience—and plenty of it—in flying the "hot" warplanes of today, yet there has been available for years a means of smoothing the road to acquisition of flying sense and ability and doing it by a method that is at once relatively rapid, inexpensive, and safe.

This means was aptly put forth by Commander E. F. McDonald, Jr., in the article "Pilots, Pilots, More Pilots," published in the July issue of Scientific American, which dealt with the definite advantages in pilot training that can accrue by the use of gliders for preliminary training. Gliding gives the beginning aviator a broad knowledge of air currents and their vagaries, a feel for flight, a confidence in his own ability to cope with emergencies without reliance on a power-plant to pull him through. The step from gliding to powered flight is far easier, far safer, than training that starts with a motor in the nose of the fuselage. And gliders are inexpensive, can be built rapidly, are easy to repair in the event of an accident. Thousands of them made available to the air forces of this nation would go a long way toward producing quickly the multitude of pilots that is necessary to our national defense.

It is gratifying to note that, since publication of the article mentioned above, public interest in glider training is on the upward climb; at the time of writing it appears that at last official recognition is being given to the advantages of the system and that, in time, it will become an integral part of our military training program.

In the meanwhile, Commander McDonald has not been satisfied with giving only lip service to the cause of gliding. Realizing that even this desirable method of training air pilots has a drawback in the shape of unreliable conditions of weather, he has designed and built a series of Wind Charger Wagons with which gliding fundamentals can be taught during periods of even flat calm. These devices, described and illustrated on page 160 of this issue, produce a controlled blast of air in which a tethered glider can take off from the ground, be put through its paces in a limited area, and landed on the take-off spot with minimum loss of time and energy. Throughout the "flight" the fledgling pilot is under continuous observation from a near-by spot, so that his operation of the glider can be constantly checked.

All of this business of glider training for powered flight adds up to the fact that this nation has been indifferent for years to an available and obvious means of providing the personnel necessary to mastery of the air. Germany grasped that means years ago, with results that are too well known to belabor here. Now that we have finally awakened to the need for national defense, and are realizing that this is no short-term affair, but a long pull that will not end when the present emergency is over, everything humanly possible must be done to build for the future as well as for the present.

As the July article pointed out, and as has been proved by German experience, gliding can serve a dual purpose. By proper promotion, it can become a national sport in which youngsters can find pleasure and education long before they are old enough to handle a powered plane. Such a national sport, supported by glider clubs and country-wide competitions, would rapidly build a pool of pilot material from which could be selected the cream of fliers for the defense of this nation.

The youth of the United States is already airminded, as evidenced by the popularity of model airplane building and of literature on the subject of aviation. Give them a chance to learn to glide and they will take to it like the proverbial duck to water. Having learned, they will take equally well to powered flight, and the United States will be in a position to claim the mastery of the air that must be established if civilization is not to receive, to be conservative, at least a serious set-back.—*A. P. P.*

STOP IT!

In our August issue we took an emphatic stand for retention in this country of the less than 350 transport planes comprising our scheduled airlines system. The article, "Keep Our Transport Planes," offered factual support of that stand. In no sense did we refer to military planes; only to ships belonging to scheduled airlines. Nor did we advocate one iota of reduction of aid to England, but we did and do strenuously insist that parceling out airliners in these parlous times is an act fraught with danger to this country; that it is detrimental to the best interests of the British; and that it is wholly unnecessary in view of the British-ordered Lockheed-Hudson bombers, ready, awaiting delivery, and easily convertible to transport use.

Industrial leaders, contemporary publishers, many others unqualifiedly supported our attitude. The *American Aviation Daily* stated: "It is reported that OPM, and the Army and Navy are against this curtailment of the airlines as injuring the expeditious performance of the defense program." Yet, despite this unanimity of public and official thought, in the face of dangerously strained United States-Japanese relations, this ridiculous amputation of our potential air-defense arm continues. Twenty-four more of our largest, newest airliners were recently transferred to England and scores more are being requested for transfer to other nations.

If the Army, the Navy, OPM, the public—as indicated by our correspondence—do not sponsor this suicidal action, then, in the name of national defense *who* does? In any event, it MUST be stopped!

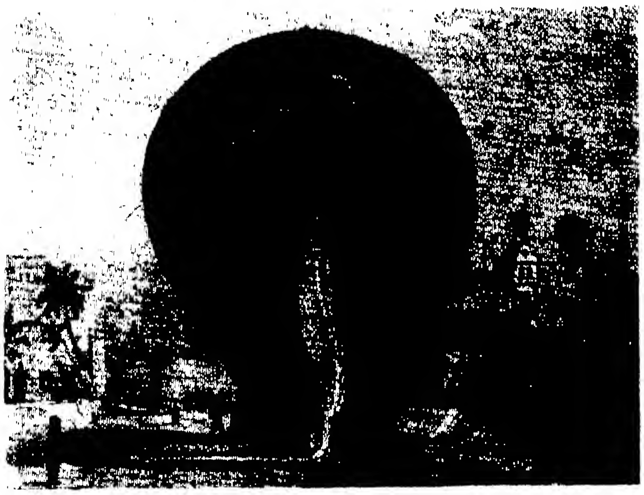
—*A. D. R., IV.*

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of September, 1891)

BALLOONING—"For some time past an exhibition of much interest to all concerned with aeronautics has been produced daily at El Dorado, a pleasure resort upon the top of the Palisades. . . It consists in the ascent of a Montgolfier balloon, to which a ribless parachute is attached. The aeronaut ascends with the two, and when a sufficient height above the earth is attained, cuts loose from the balloon, effecting his descent to earth in the parachute. . . The balloon is made of sheeting sized with a mixture of glue, alum, soda, salt, and whiting, in water. At the mouth of the balloon a hoop 8 ft. in diameter made of buggy wheel felloes is attached; from this hoop four ropes, called quarter guys, are brought down . . . to which the parachute



is attached. The parachute is made in gores, and in its center has a 12 in. hole. From its periphery thirty-two cords lead down to what is known as the concentrating hoop, a strong wooden ring 18 in. in diameter, which the aeronaut grasps in making his ascent. . . As the ascent is made, the entire distance from the top of the balloon to the aeronaut hanging to the parachute is about 175 ft.; the inflated balloon is about 40 ft. in diameter."

RAIN-MAKING—"There are now so many cloud compelling rain producers turning up that any opulent person who is interested in the weather can hire one of them for his own convenience. But suppose a man who would like to enjoy a shower on a warm afternoon orders his cloud compeller to produce one at a time when his next door neighbor desires to take a walk in his garden under the sunshine, what will ensue? Will the rain producer be liable to be sued for damages by his neighbor, or will the case be settled by arbitration?"

TRANSATLANTIC—"It is claimed the steamer *Majestic* is the most economical coal burner of any of the Atlantic 'high fliers.' She burns 220 tons of coal a day, shows 19,500 horse power, and makes an average of over 20 knots, or 23 miles per hour, throughout the Atlantic passage. There are only two other ships that have reached this speed, namely, the duplicate ships the *Teutonic* and the *City of Paris*. But there are a few other vessels that come near this speed."

NO PRIORITIES THEN—"Interesting experiments have recently been made on the Lake of Zurich with a boat built entirely of aluminum. The boat weighs only about half a ton—viz., about half the weight of an ordinary boat of the same size. . . It carries eight persons, and, with a petroleum engine of only two horse, easily makes six miles an hour. Aluminum not being subject to rust, the permanent color of the boat is a beautiful dull white, while the chimney, being of polished aluminum, shines like silver. The trial trips of the boat were eminently successful."

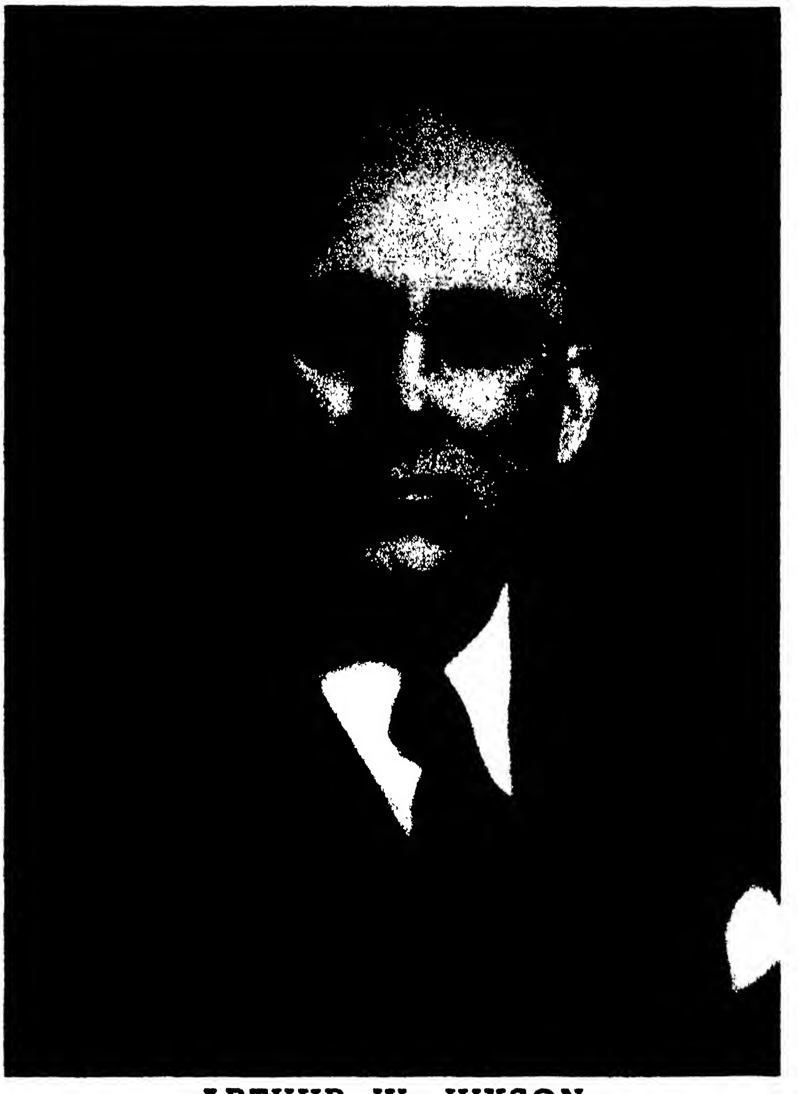
STIMULATION—"To the usual well known ways of stimulating muscles to contraction, viz., electrical, thermal, mechanical, and chemical, M. D'Arsonval has recently added that by means of light. He could not, indeed, get any contraction in a fresh frog muscle, when he suddenly threw bright light on it in a dark chamber; but having first in darkness stimulated a muscle with induction currents too weak to give a visible effect, and then suddenly illuminated the muscle with an arc light, the muscle showed slight tremulation."

GLASS—"A new use has been found for waste glass by Messrs. Rostaing, Garchey and Geille, of Paris. Any fragments of broken glass of various colors are mixed together, after having been broken to a suitable size; they are then placed in moulds lined with silica, talc, or some other resisting material and fired. A coherent mass is produced which can be dressed and cut into blocks, which are, of course, irregularly colored. Such blocks may be used as artificial marble. . . Fine decorative effects can thus be produced. Designs in relief can be obtained by pressure while the block or slab is still plastic."

PYROMETER—"It appears that at last something like precision has been secured in a thermometer for high temperatures. This much-needed instrument is made by Mr. H. L. Callender in the form of a platinum resistance, the simplest shape of which consists of a coil of fine wire welded to leads of comparatively low resistance. The electrical resistance of such a wire varies according to its temperature; so that the reading of the one gives the other by consulting a table prepared with reference to the zero of the instrument. . . Mr. Callender declares that if the wire is pure to start with, and is protected while in use from strain and from contamination, its resistance, after having once been annealed, is always very near the same at the same temperature."

CRANE—"A huge steam crane, called a steam Titan, built by Messrs. Ransomes & Rapier, will be chiefly employed for transporting blocks of concrete weighing 32 tons. . . The weight of the Titan, without water ballast or load, is 152 tons, and with ballast 170 tons. All the motions of the appliance are under perfect control by means of a set of levers situated on a platform and within easy reach of the single operator. A feature of importance in connection with this appliance is that it has to be capable of slewing round in a complete circle. . . The radius described by the arm is 50 ft., and to minimize the shock produced by stopping a load, owing to the momentum acquired when being slewed round, spring braking devices are introduced in connection with the gearing so as to bring the arm to a gradual stop."

Personalities in Science



ARTHUR W. HIXSON

DETERMINED to make this country self-sufficient in strategic metals, Professor Arthur W. Hixson, executive officer of the Department of Chemical Engineering at Columbia University, is seeking through laboratory research to uncover new and inexpensive methods of extracting aluminum, tungsten, vanadium, and molybdenum from low-grade ores which exist plentifully in this country.

Enough high-silica, low-iron aluminum deposits can be found within our boundaries to supply the needs of the nation's defense program for many years to come, Professor Hixson believes.

A similar interest in the full utilization of products on hand converted Professor Hixson from a farmer operating a 160-acre grain and cattle farm in Brown County, Kansas, into a chemical engineer. After graduating from the Northeastern Kansas Farm Institute in 1899, Professor Hixson decided to study chemistry as a means of salvaging waste farm products.

Born on July 7, 1880, near Mifflinburg, Pennsylvania, Professor Hixson attended the University of Kansas where he received the bachelor of arts degree in 1907 and the master of science degree in chemistry and metallurgy in 1911. During the years preceding his doctorate in chemical engineering, which was conferred upon him by Columbia in 1918, he was engaged in work as an assayer and metallurgist, participated in large-scale human and animal metabolism tests sponsored jointly by the government and the meat-packing industry, taught mining, metallurgy, and industrial chemistry at the State University of Iowa and the University of Iowa.

During the first World War, Professor Hixson served as a chemical engineer in the High Explosives Division of the U. S. Army Ordnance Department, supervising the production schedules of 31 explosives plants and the construction of chemical plants.

As a member of the Columbia faculty, which he joined in 1919, Professor Hixson organized and pioneered in courses which are now basic in the University's curriculum. His courses in Chemical Plant Design, Process Development, and Unit Operations have attracted graduate students from all over the world. During his 23 years at Columbia, he has served as a consultant to many firms in the chemical industry, gaining practical experience that has enriched his teaching and given point and direction to his research.

For the past ten years, Professor Hixson has directed research that has produced valuable developments in the petroleum, paint, and plastics industries. He has devised methods of accurately determining the size and power of large-scale agitating equipment from a study of models; discovered easily manufactured solvents for refining lubricating oil; isolated easily liquefiable hydro-carbons to be used as selective solvents for refining resins and fatty acids; devised a method of producing chlorine and sodium sulfate (which were imported in large quantities from Germany before the outbreak of the present war) from common table salt and sulfur dioxide; and has improved titanium pigments used in durable, non-tarnishable paints.

Among Professor Hixson's hobbies is city planning; of the 18 years he has lived in Leonia, New Jersey, he has been a member of the Board of Education for nine and chairman of the Town Planning Board for 17. Anticipating a rapidly changing civilization, he has drawn up a master plan of his and neighboring towns to care for future needs in housing, transportation, education, and recreation. He is recognized as Leonia's local historian for having compiled the town's colonial history. Also avidly interested in developing new species of plants, he has studied the effects of X-rays and ultra-violet light on producing variations in plants which he grows in his soil-less laboratory at home.

PORTABLE ATOM SORTER TO AID SCIENCE AND INDUSTRY

THE mass spectometer or "atom sorter" has been placed on wheels so that it can be moved from job to job. Heart of this device is the curved vacuum tube, surrounded at the bend by an electromagnet, shown above. In this analyzing machine atoms of chemical elements are sorted as to weight, the magnet bending the paths of lighter atoms more than those of heavy atoms, as they shoot through the tube at speeds up to a million miles an hour. More details on page 144.

97TH YEAR

SCIENTIFIC AMERICAN

SEPTEMBER 1941

HOW GOOD ARE AMERICA'S WARPLANES?

Analysis Shows Superiority in Factors That Count

JAMES L. H. PECK

IF THERE is anything the matter with our fighting craft, the war has been in progress long enough for the military and industry to have corrected the shortcomings. There have been a sufficient number of Royal Air Force experts over here and enough official and unofficial observers over there for the message to have been delivered. The American people, who, after all, are paying for these planes, certainly deserve to be acquainted with at least certain aspects of the deficiency, if such exist.

If our warplanes are as good as or better than any known to be in service or projected by the belligerents, this is hardly the time for the people to be told that our ships are second rate as compared with particular types of RAF and Nazi craft. The queer list of adjectives that have been tied to the tails of our military and naval aircraft have, for the most part, been directed at pursuits, fighters, and interceptors. The superiority of bombers of all types, and of our reconnaissance ships and trainers, is much too obvious for an intelligent and airminded public to be told otherwise: Billions of dollars worth of contracts speak for themselves, [illegible] best fighting planes [illegible] bad investment for even a country in Britain's straits.

The cleverest jugglers in the aviation industry are the designers and engineers who are charged with the development of combat planes. They must continually balance one factor against another, add a bit of this and subtract a little of that; their job is one of compromise. Consideration must therefore be given these factors when comparison of warplanes is made.

In the military sense, these essentials are always relative. There is the matter of speed, which should be in excess of that of enemy pursuits and bombers so that swift attack and rapid withdrawal from combat remain your prerogatives instead of those of the adversary. Equally important is maneuverability, that adroitness or flexibility that permits the ship to be easily and rapidly flown through whatever aerobatic maneuvers are

NATIONAL DEFENSE

necessary to bring one's guns to bear on the enemy, or to escape his return fire. The top altitude, or ceiling, that the plane is capable of maintaining should be proportionately higher than that of hostile fighters and bombers, and rate of climb must also be higher to permit one to out-climb the enemy; top man is usually best man in a sky scrap. In order that operations will not be confined to too limited an area, and so that the fighter may remain aloft long enough to accomplish the tactical mission, it must be provided with an adequate range. Another vital flying characteristic is the plane's take-off and landing ability, and these are phases where speed is not at all desirable. If the ship cannot get off the ground and return to earth without jeopardizing the pilot's life, the other attributes are of little avail.

The combination of these six essentials is used to determine performance; performance, however, is not an end in itself but is a means to an end—that of bringing one's firepower to bear on the enemy and destroying him. The juggling and compromise of these factors is necessitated by air war tactics and the designers who are the cleverest jugglers turn out the ship with the finest all-around performance.

THERE are "built-in" qualities, however, which cannot be safely compromised. Combat planes must be built to a higher factor of safety than other types because of the speeds and stresses peculiar to these craft. Airmen must have complete confidence in their ships' ability to take it as they perform the necessarily violent and rapid maneuvers during combat. Pilots must be furnished adequate visibility from their cockpits, so that they may have an unobstructed view of the air and whatever happens to be in that air, without undue twisting and turning. Ten minutes of fast action can exhaust the hardiest of fliers. To further pilot efficiency, the ships should be provided with reasonably comfortable seats, heated suits or cockpits, and oxygen equipment. These are not non-essential luxuries, as some critics of American planes would have us believe. Cold, cramped aviators are at a disadvantage physically and psychologically against adversaries who are so equipped. Security measures dictated by lessons learned from "war research" include the installation of armor (particularly beneath the pilot's seat, at his back, and behind the legs), windshields of bullet-proof glass, and leak-proof fuel tanks. The latter serve a double purpose in greatly reducing fire hazard and in eliminating engine failure due to loss of fuel. Accessibility of the plane's engine, armament, and other vital parts must be made pos-

Official U. S. Navy photograph
Grumman Skyrocket, Navy version; 1500-horsepower Cyclones

sible by the installation of handy panels and cowling to facilitate easy, rapid maintenance. Minutes often count in air war, and the airplane is the most useless of weapons while grounded.

Last, but most important of all, is the fighter's firepower—that potential destructive force of the ship's armament. The ultimate aim of combat is to gain "fire superiority" over the enemy and thereby destroy him.

America is allegedly building fighting craft which do not "belong in the same air" with the late-type RAF and Nazi warplanes. If there is a deficiency, it must lie within one of the mentioned factors, or within a combination of two or more of these essentials.

An accompanying table gives figures which are generally accepted at this time showing the top speeds (at optimum altitude ranging from 12,000 feet to 25,000 feet) of five ships of the U. S., Britain, and Germany which are in use or in production at this writing.

On the basis of these figures, a few of which are unofficial, American craft certainly appear speedy enough to meet and best any of the European craft. Indeed, for the sake of conservatism, one might hold as much as 20 miles per hour in reserve for the Lockheed and Grumman and all five models would still compare most favorably with those of our contemporaries. True enough, the British are just commencing production of their Hawker Typhoon, powered by a 2400 horsepower Napier Sabre engine, which has been credited with a test-flight speed of 440 miles per hour, and Germany is known to be starting a new Heinkel fighter down the line which is almost as fast. [NOTE: The Westland Whirlwind, highly touted twin-engined RAF interceptor developed serious "bugs" and has been withdrawn from production, according to British sources.]

But if one is to follow this line of reasoning concerning "things to come," consideration must certainly be given the Navy's Vought-Sikorsky F4U-1, boasting a speed of 420 miles per hour, which is just about to go into production, and the Army's Grumman YP-50 version of the Skyrocket—which, according to reports, will be somewhat faster than its Navy stablemate—undergoing pre-production testing. One can go even farther to consider the 17 other "hush-hush" experimental models, clear up to the designation XP-63, now at Wright Field, and the several types at the Anacostia Naval Air Station. In the project stage are several prototypes with speeds exceeding 500 miles per hour. Outstanding among these, according to advance engineering data, is the Williams Aero Research Corporation's direct-lift pursuit-interceptor.

The transition from experimental status to first-line squadrons takes time, but these ships may be available before they are actually needed; that is, if we think in terms of national defense or protection of the western hemisphere.

The fact that several of our pursuits and interceptors boast performance comparable with higher-powered foreign craft would seem to turn the critics' loudest arguments against themselves: this concerns United States aircraft engines in general and air-cooled motors in particular.

Because radial air-cooled motors do not require the "plumbing"—radiators, ducts, pumps, and jackets—necessary on liquid-cooled types, they are many pounds lighter in weight. Air-cooled motors have fewer working parts, and this makes them less vulnerable to

Official U. S. Army Air Corps photograph
Flying cadets at Randolph Field study

COMPARISON OF WARPLANES, POWER, AND SPEED

United States				
Lockheed P-38E*	(Army)	2	1150 hp Allison	458 mph
Grumman F5F-1 Skyrocket	(Navy)	2	1500 hp Wright Cyclones	420 mph
Bell P-39A Airacobra	(Army)	1	1150 hp Allison	395 mph
Bell FL-1 Airabonita	(Navy)	1	1150 hp Allison	398 mph
Curtiss P-40A	(Army)	1	1090 hp Allison	360 mph
Great Britain				
Hawker Tornado		1	1780 hp Rolls Royce Vulture	425 mph
Supermarine Spitfire III		1	1600 " " " Griffin	400+ mph
Supermarine Spitfire II		1	1250 " " " Merlin	385 mph
Supermarine Spitfire I		1	1030 " " " Merlin	367 mph
Hawker Hurricane II		1	1250 " " " "	365 mph
Germany				
Focke-Wulf Fw-187		2	1375 hp Daimler-Benz	400+ mph
Focke-Wulf Fw-198		1	1500 " " "	400 mph
Heinkel He-113		1	1375 " " "	382 mph
Messerschmitt Me-110		2	1150 " " "	370 mph
Messerschmitt Me-109		1	1150 " " "	354 mph

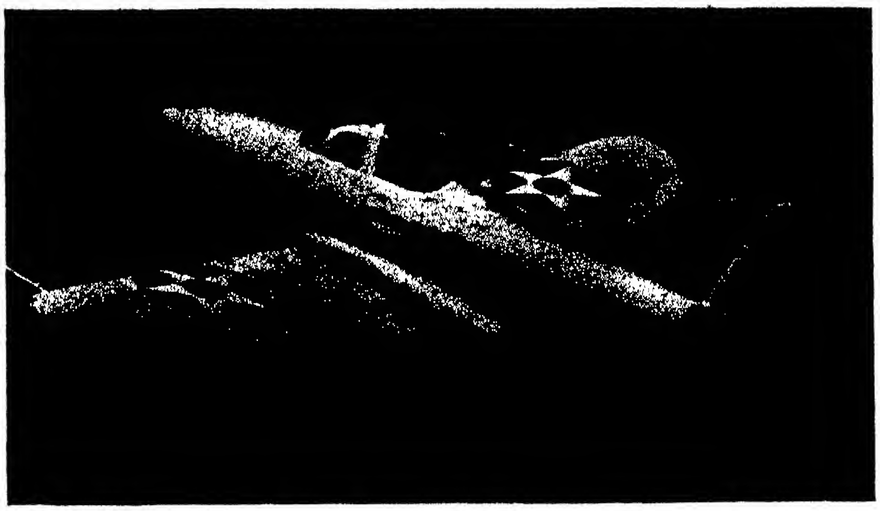
* Production model. Gen. Henry H. Arnold, Air Corps Chief, announced last fall that the P-38 could ~~fly 500 mph~~, but this reference is believed to have been made to an experimental model powered by two 2500 hp Wright Tornado engines, the most powerful in the world.

enemy fire and lends them to easy, rapid maintenance and fewer overhauls. Last, but not least, the radials may be turned off the production line in greater numbers within a given time.

The linear shape of liquid-cooled motors, on the other hand, makes for efficient streamlining which is so important for high performance; the radials present their flat frontal area to the air, thereby furnishing a great amount of head resistance. The streamlined liquid engines provide the pilot with good forward visibility on single engined planes; the airman must peer around the larger cowl of the round motor, which is a disadvantage in combat.

The case of the radial engine might well have been stated in the past tense, inasmuch as the disadvantages have, for the most part, been overcome. The Pratt & Whitney Company's Double Wasp engine, which, incidentally, is good for almost 1000 horsepower more than the better-known liquid-cooled Allison, has been fitted with an extra-long shaft and gear box that permit it to be fully enclosed in a sleek, conical cowling heretofore possible only with liquid-cooled engines. The sensational Vought-Sikorsky fighter and Republic XP-47B Thunderbolt interceptor are both powered by a conventional snub-nosed model of the Double Wasp that turns up more than 2000 horsepower. Biggest news yet is the 3200 horsepower

a partially dismantled Allison engine



Official U S. Navy photograph

Navy's Bell Airabonita, faster than the Airacobra, has greater range

three-row Wright motor with a triple supercharger, still very secret.

In the meantime, development of the liquid-cooled engine is being carried forward. The most promising is the also-secret Wright Tornado motor which is good for some 2500 horsepower. Data are restricted, but it is believed to be a development of the famous Curtiss Conqueror (D-16) engine. This engine, too, has already been flight tested. The new Ford motor, a V-12 type revving up 1800 horsepower, is being tested, and Continental Motors has developed a trim 12-cylinder job of 1700 horsepower. The General Motors' Allison has been boosted to 1325 horsepower, but rumor has it that this engine, which has developed any number of "bugs," will be discontinued in favor of the Tornado, which makes good sense.

THE Associated Press carried a very interesting dispatch as far back as February 11—when there were but a few late-type American pursuits in England and fewer still in front-line action—quoting two crack RAF pilots on the behavior of one of our new pursuit jobs.

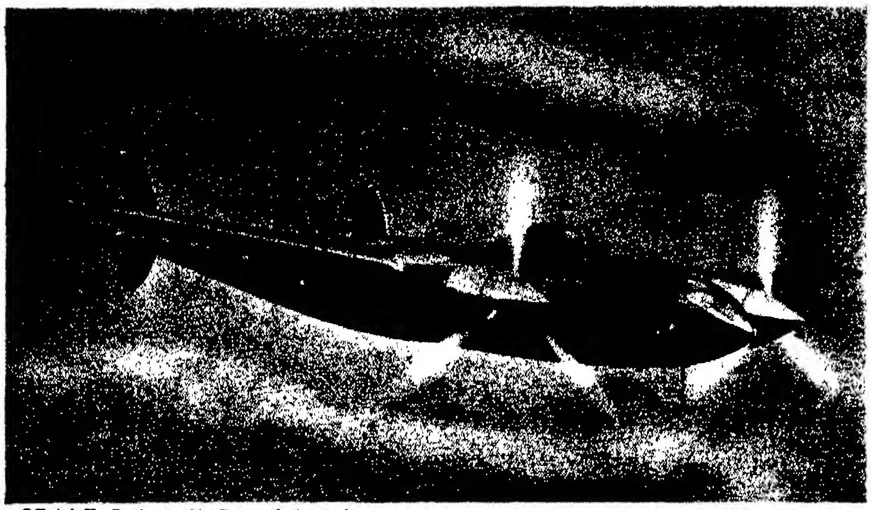
"That's a dashed fine machine. I had my legs on the Hurricane and I could even turn inside him," declared the victor to visiting fliers and newsmen as he climbed from the cockpit of a Curtiss 81-A Tomahawk—export version of the Army's P-40—following a ten-minute mock combat over a production station somewhere in Britain.

The vanquished airman was quoted as replying: "You turned inside me—never thought I'd see a plane that could do that to a Hurricane. The Tomahawks are faster than I expected. You were fast enough to catch me."

The former was an RAF Wing Commander who had spent just 15 minutes familiarizing himself with the controls and feel of the American ship, and the man he "defeated" was a famed Squadron Leader. The occasion was an air demonstration arranged by Lord Beaverbrook's Ministry of Aircraft Production for the benefit of some hundred officials and correspondents of the United States, Britain, and the Dominions.

The men of the RAF are doing the fighting; they know more about air war than we do over here. When they hang rave tags on our warplanes, that praise emanates from the highest authority. Even if a certain amount of approbation from higher quarters is to be discounted as "flattery" or "propaganda," comments of the pilots whose lives and missions depend upon the excellence of the ships they fly are not to be so easily taken with the proverbial grain of salt.

Thanks to clever supercharging, our fighters boast ceilings and rates of climb to those top altitudes which, in many cases, exceed similar phases of performance of British and German planes that are powered by engines of greater horsepower. United States pursuits have long been noted for their exceptional range, particularly the shipboard fighters, some of which can fly farther than five types of European medium bombers I can name. Not a single fighter developed within the last ten years in this country became infamous because of its evil handling qualities. Contrast this with the beautiful


Official U. S. Army Air Corps photograph
Lockheed P-38E interceptor has attained a speed of 458 miles per hour

and otherwise-efficient pilot-killer, the Nazi Heinkel He-112. A better all-around warplane than the more famed Messerschmitt Me-109, the Heinkel was jerked off the production line because of its dangerous take-off and landing characteristics.

If never before, the exceedingly high standards of the aircraft industry of this country, the excellence of materials, and the rigid specifications prescribed by the services are being demonstrated by the ability of our aircraft to "take it" in battle. There have been no reports of locked controls or shed wings in high-speed dives where United States craft are concerned, which is more than three of the belligerents may truthfully say. Vulnerability is further decreased by the use of armor, bullet-proof glass that will stop even a .50-caliber bullet, and self-sealing tanks.

THE mission of pursuits, fighters, and interceptors, however, is the dispensing of firepower and punishment rather than the taking, and there has been considerable speculation as to whether or not American planes could trade blows with German and British craft. Our planes are allegedly weak in firepower, but only allegedly. It has been pointed out that British fighters were carrying eight machine guns two years ago, at a time when first-line American ships were mounting only half that number, and, in many cases, only two guns. What was not made quite so clear was the fact that our airplanes must be designed for missions that would conform to American strategical demands, not —excepting, of course, the ships we are building for the RAF—British needs or German requirements. Our interceptors and pusuits must, generally speaking, have a greater range than foreign types because of our long coastlines and the tactical necessity for shifting from one section of the hemisphere to another. One of the characteristics RAF men admire most about our planes is the generous range. It will be recalled, however, that extensive range is gained at the expense of one or more of the other factors, in most cases. Instead of cutting down on speed or maneuverability, we carried fewer guns.

It was not, as is generally believed, during the early phases of the Battle of Britain that the need for more armament became apparent to United States tacticians, but at the time our first exported pursuits (Curtiss 75-A Hawks) went into service for France's Armée de l'Air. I say more armament, rather than heavier guns, because, as the critics also fail to point out, we have mounted heavier armament than the Europeans, and still do. American planes have been armed with heavy .50-caliber machine guns for several years, while only the very latest British and German craft are fitted with .50-caliber guns. They have continued use of the less-effective .303 rifle-caliber weapons and have only recently supplemented these with the larger guns. The first really successful 37-millimeter cannon was developed in this country a few years ago by the American Armament Corporation, and the only 37's being used abroad today are those on American-built planes. Even the ammunition for these guns is being imported from the United States. The RAF and *Luftwaffe* are arming their own craft with the smaller, less effective 20- and 23-millimeter varieties.

The armament problem derives from this: the lighter the caliber of the gun, the faster the firing rate and the shorter the range. Unless the pilot happens to be hit, all-metal ships can withstand an amazing amount of rifle-caliber fire and keep going. The .50's fire at a slower rate—about 650 rounds per minute against 1250 or more per minute for the .30's—but do much more damage. The .50-caliber Colt-Browning has an effective excess range of 125 yards—from moving station—over that of the rifle-caliber type, and an armor-piercing bullet from the former will penetrate ¾-inch armor at 450 yards. However, two .30's and 500 rounds of ammo weigh less than one of the larger guns and only 100 rounds of .50-caliber ammunition. Use of cannon makes the problem more complex. The one-pounder and 100 rounds of ammo, which comes in clips of five shells, weigh 299 pounds and the gun shoots at the rate of only 125 rounds per minute. Six rifle-caliber guns and 100 rounds of ammo for each add up to about the same amount of avoirdupois, but a direct hit from one of the cannon shells will blow a pursuit ship apart or disable the largest of bombers, and the cannon has six times the effective range.

COMBINATION, obviously, is the best solution of the problem; fast-firing guns for close-in fighting and cannon for distant pot shots. Little wonder, then, that the RAF men like our Bell Airacobra so well. For a single-engined pursuit-interceptor, the armament is ideal: four .30's, four .50's, and the 37mm cannon. This most certainly tops the eight .303 rifle-caliber guns of the Hurricane and Spitfire, and the four rifle guns and 23mm cannon of the Nazi Messerschmitt Me-109.

The latest craft of the belligerents carry much more armament, however. The Focke-Wulf FW-187 Zestörer, according to unconfirmed reports, mounts four 20mm cannon and the same number of .50-caliber machine guns. The RAF's new Tornado is reported to be carrying eight rifle-caliber guns and three 20mm cannon. Those boys aren't playing! Neither are we. On information from a highly reliable source, I have it that both the Lockheed interceptor and the Grumman F5F-1 fighter are mounting two 37mm cannon,

four .50's and four .30's. Add to this the fact that our ships are fitted with the electric optical gun-sight, admittedly the finest in the world, to aim all this artillery accurately, and the sum totals up nicely for the red, white, and blue. With an eye to the future, we have several types of even more lethal aircraft weapons under experimentation, but all data on these are restricted by Washington.

Here, then, is the warplane picture: Speed is essential mainly for purpose of catching the enemy. Rate of climb and ceiling, for the purpose of getting up to meet—and top—him. Maneuverability, for the purpose of out-flying the adversary and thereby gaining a favorable shooting position. These are all to little avail if one's fire-power is too weak to bag him after catching. By the same token, the heaviest firepower is useless if one cannot catch and out-maneuver the enemy so as to bring that armament to bear upon him. Balance is achieved through the interaction of engineering ingenuity, research, production, and the time in which to put these to work. America has more of all four than any country in the world.

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Half Tractor, Half Track

High Speed, Maneuverability, Armor Plate Protection in New Army Reconnaissance Car

Seating arrangement, gas tanks, and machine-gun rail at edge

NOW UNDER production for the United States Army Ordnance Department is an armored and armed scout car designed for reconnaissance work over soft and broken ground as well as on level ground or highways where the vehicles can attain a speed of 50 miles per hour. Known as the Half-Trac, this vehicle is much the same as the conventional scout car, but, instead of having regular rear wheels, it is provided with an endless belt track which is driven by the forward axle of the rear bogie. This construction gives great traction power on soft and broken ground; at the same time, power is applied to the front wheels so that driving force is attained at both the front and rear.

The design of these jobs permits maximum maneuverability and the ability to climb in and out of shell holes and trenches. They will also go through mud, or ford streams up to a depth of 2½ feet. A large roller at the front end helps them out of holes or ditches. In test operations they have been able to climb out of a six-foot trench. Eight speeds forward are available.

THE Half-Tracs are fully covered with ¼-inch armor plate for protection against rifle or machine-gun bullets. When subjected to fire, there are a series of armor plate shutters which close down over the radiator, and an armor plate shield with two port holes which takes the place of the windshield.

Although these vehicles are not intended for combat purposes, they carry three machine guns—two of .30 caliber and one of .50 caliber—mounted on a special gun track which encircles the top rim of the vehicle and permits full 360-degree action. Each of these vehicles has an army-type pintle on the rear for quick attachment of any vehicle to be towed. Inside the body is a two-way radio outfit with special center post antenna. The radio enables the officer and crew to keep in touch with field headquarters. Low folding seats with wells for the feet accommodate a crew of eight, plus a driver and car commander.

Chassis of the scout car described on this page. This type, manufactured by The White Motor Company, is powered by an engine developing 147 brake-horsepower. *Right:* A bank-climbing test

Infra-Red Does the Trick

Radiant Energy From an Efficient Source is Doing Industrial Jobs Faster and Better

A. P. PECK

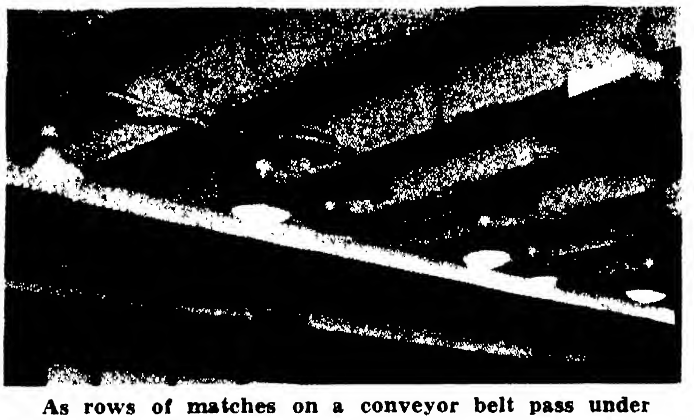
Bringing a surprisingly large number of advantages to a wide range of industries, radiant energy, or infra-red heating, with specially designed incandescent lamps holds promise of invading even the home sometime in the future, providing a new means of heating individual rooms or perhaps the whole house, drying the family wash, and possibly cooking the food. But these menial household tasks are still subjects for those prophets whose delight it is to gaze into the crystal ball of science; of more immediate import are the industrial applications of this relatively new means of applying heat for a variety of purposes.

To attempt to list all the uses to which infrared heating equipment is being put today would require far more space than is available. A few typical examples, however, will help point the way.

In the manufacture and repair of electric motors and transformers, the windings may be dried rapidly and thoroughly by the use of the incandescent bulbs. In one application, 30 of the lamps, of the size rated at 250 watts each, reduced drying time for a motor rotor to 50 percent of that required by a 42-kilowatt drying oven of the conventional type.

Granulated cellulose acetate must have the moisture removed from it before it is placed in an injection molding press. Infrared lamps applied to this job made it possible to dry the material in 15 minutes; former equipment consisted of a steam dryer that required one hour to achieve the same result.

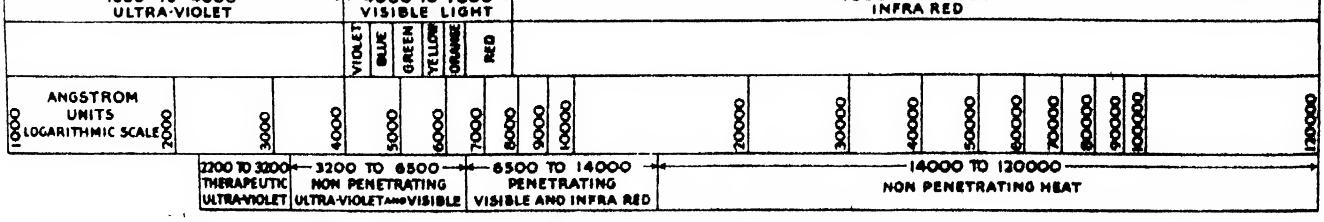
In an automobile engine assembly plant, pistons are expanded under radiant heat to permit insertion of closely fitting piston pins. Blueprints are produced faster, paper is dehumidified for lithography, label paint is fused to glass bottles, photographic paper and film are dried rapidly as are also paint and lacquer finishes, and a hundred and one other operations are carried on faster, more economically, by the use of these magic lamps of science.



As rows of matches on a conveyor belt pass under infra-red lamps, the tips are dried quickly, safely

Before dwelling at some length on the reasons why radiant heat is of such great industrial value, a brief preliminary explanation may be in order. Wherever heat is to be applied in an industrial process, whether it be for drying a surface film, for reducing humidity, for expanding parts by temperature change, or whatever, there are three general methods of transmitting the energy from the source to the surface or object to be heated. These three methods are conduction, convection, and radiation. Conduction of heat requires a solid body for transmission; when only a part of an iron rod, for example, is heated in a flame or by any other method, the rest of the bar increases in temperature as the heat is conducted through the solid. Convection heating makes use of a liquid or gaseous medium for transmitting the heat; an example of this is the ordinary oven where the interior air is heated by one method or another and this air, in turn, passes the heat to the object in the oven. Radiant heating, on the other hand, requires no known medium of transmission; the most familiar example of radiant heating is the life-giving warmth which the earth receives from the sun. Here infra-red heat rays emitted by the sun pass through the subzero void of space, producing no effect until they reach, and are absorbed by, the earth and objects on it. Upon absorption, however, the energy appears to our senses in the form of heat.

Thus radiant energy heating involves the use of infra-red rays, that part of the energy spectrum at the long wave end of the visible light portion and beyond. As shown in the section of the spectrum scale reproduced here, in which wavelengths are rated in Angstrom units (one Angstrom unit equals one one-hundred millionth of a centimeter), those infra-red or heat rays ranging from about 6500 to 14,000 Angstroms are generally considered as most effective for this work; beyond 14,000 Ang-



Courtesy North American Electric Lamp Company

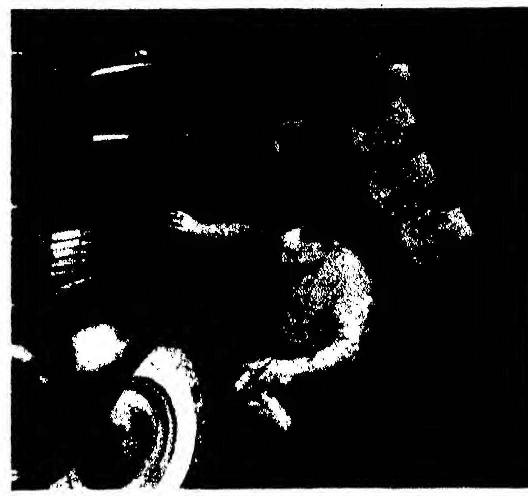
Infra-red radiation for industrial uses lies in the 6500 to 14,000 Angstrom band

stroms the infra-red continues to 120,000 Angstroms, but this part of the spectrum is of little present interest to the researcher in the subject of infra-red heating. Just where to draw the finish line in the radiant heat part of the spectrum is still a moot question, open to theorizing and further experimental work.

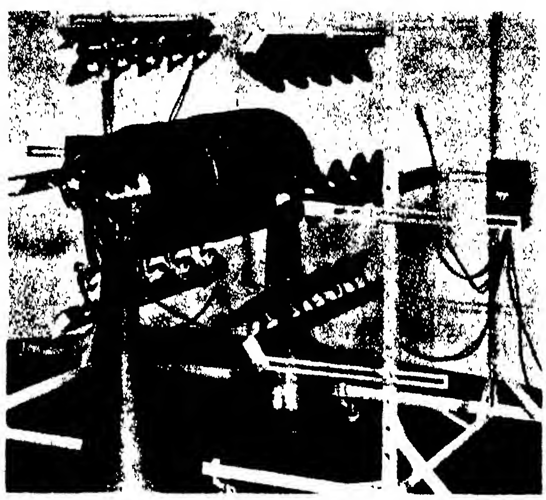
From this it will be seen that, given a source of infra-red rays, heat may be transferred from that source to an object with minimum losses, since it is unnecessary first to transfer heat to a transmitting medium and then once more transfer the energy from the medium to the object. Such a source of energy is available in the incandescent lamp. For years lighting engineers have directed their efforts toward producing a light source which would give a maximum of light and a minimum of heat for the power involved. Now heating engineers have reversed the process and are producing an incandescent lamp which will emit a minimum of visible light and a maximum of radiation in the useful part of the infra-red spectrum. So successful have they been that present-day industrial heating lamps convert as high as 90 percent of the energy consumed into heat, much of which is in precisely that part of the spectrum which is most useful for industrial purposes.

PROBABLY the first large industrial application of radiant energy lamps was made by the Ford Motor Company, where the lamps were put to use for speeding the drying of automobile finishes. Since then the lamps have been improved and their use expanded to include a multitude of drying operations in the food, photographic, chemical, electrical, and a host of other industries, as well as other applications which call for economical heating for a variety of purposes.

The advantages of radiant heat in industry are so many and varied that it is difficult to list them in the order of relative merit. Since cost is frequently an important factor, however, it might be well to mention it first. Initial investment cost for an infra-red heating set-up is low, since no elaborate insulated ovens are necessary. The lamps may be mounted on simple and inexpensive frames, taking up a minimum of floor space. In some cases it is possible to suspend the lamp frames above existing conveyor lines, thus taking up no more room than is required for the conveyor itself. Still on the subject of cost, it is stated that maintenance is low, since the lamps operate at a comparatively low filament temperature and hence have long life.



Even small shops that do automobile body repair jobs find profit in portable radiant heat units for drying paint patches



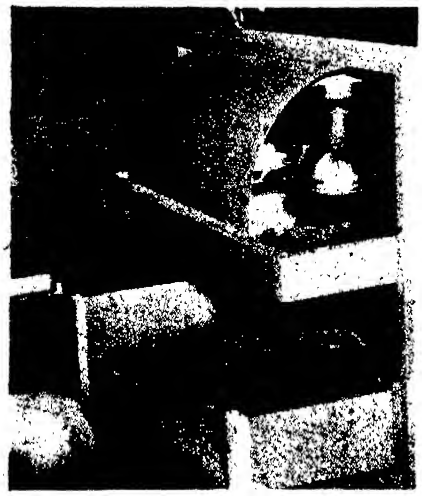
New or repaired rotors for electric motors are economically dried by infra-red

Due to the very rapid rate of energy transfer, according to one theory, infra-red heating is fast and therefore economical. Another theory to account for the efficiency of radiant heating states that the rays penetrate the surface finish or film or the pores of the surface, thus causing more rapid heating or drying than can be had with more conventional furnaces. In any event, the greater speed of operation results in lower total processing costs in many industries.

Since radiant heat is of essentially the same nature as light, the lamps which furnish the infra-red rays may be turned on and off or controlled and directed in much the same manner as incandescent lighting. When the current is turned on, the heat is there in full force with no delay. There is no need for keeping furnaces up to heat for long periods of time when the heat is needed for only short intervals. Convenience of operation enters the picture here; the only attention needed under ordinary conditions is a flip of a switch. Small installations of infra-red lamps may be entirely portable and moved from place to place as needed.

ON THE other side of the ledger are certain limitations of this form of industrial heating, and these must be considered in order to gain a clear picture of the whole situation. As stated before, one of the uses of infra-red heating is to speed the drying of surface finishes on automobiles. It, as well as other conventional methods of heating, cannot be used satisfactorily, however, for drying finishes that depend on oxidization as well as evaporation for the ultimate result. Thus it is barred largely so far from use in drying finishes containing linseed and similar oils. Where printed fabrics with a wide range of colors in the patterns are to be dried, infra-red may not be satisfactory; the darker parts of the fabric which absorb the greater amount of the rays, and hence are subjected to a greater degree of heat, may be overheated before the lighter colored parts of the material are dry. Conversely, if the degree of heat is so regulated that the highly absorbing parts are not overheated, the rest of the fabric may not dry sufficiently. There may be other similar obstacles to the use of infra-red heat, but there are so many desirable features of the system that any disadvantages are, in general, far out-weighed.

Although radiant heating is being used for many purposes there is still much to be learned about it.



Removing moisture from pre-formed plastic before molding

In fact, as has been hinted, there is no complete agreement among researchers about the exact way in which results are achieved. It is known that when infra-red radiation is used to dry a lacquer film the film drys rapidly without the formation, first, of a surface skin. Engineers of the North American Electric Lamp Company put it this way: "It is possible to obtain drying results with lower temperatures and/or less time because of the direct penetrating action of infra-red rays . . . a minimum of energy is lost through convection or conduction. Additional benefits of this penetrating action is the fact that surface films do not form on paints, lacquers, and so on, to slow up drying below the surface . . . drying proceeds throughout the material from the point of maximum penetration at the same rate of speed. Furthermore, vapors are free to escape so that infra-red drying is carried on in a lower humidity—a condition that speeds up drying."

From this explanation has come a frequently expressed thought that infra-red drying makes it possible for paints and other surface finishes to "dry from the inside out." This phrase has been questioned as to accuracy in some quarters; therefore the author put it up to one of the engineers of Westinghouse Electric and Manufacturing Company, who replied as follows:

"In my opinion the advantages of radiant heat over other conventional methods are due very largely to the much higher rate of energy transfer from the source to the object being heated. When the temperature differential between two objects is great, the rate of energy transfer is relatively high. As the temperature of the object being heated approaches the temperature of the source of heat, the rate of energy transfer falls off very rapidly. When radiant heat is used, we have as a source of energy a lamp filament operating at a temperature far in excess of that usually required for industrial drying and heating purposes. Consequently the temperature of an object being radiated, even when at its maximum required temperature, does not approach the temperature of the lamp filament. This being true, there is little or no change in the high rate of energy transfer.

"As to whether the theory of 'drying from the inside out' is a myth depends on the interpretation placed on this explanation," the engineer continued. "We do know that if radiant energy is projected on, for example, a finish applied to a metal surface, part of the energy is absorbed by the finish itself while the rest passes through the finish to the metal. Obviously the metal is heated and if you wish to express it that way, the paint 'bakes from the inside out.' This condition, however, occurs when convection heating is used but of course with a much lower rate of temperature increase than in the case of radiant heat."

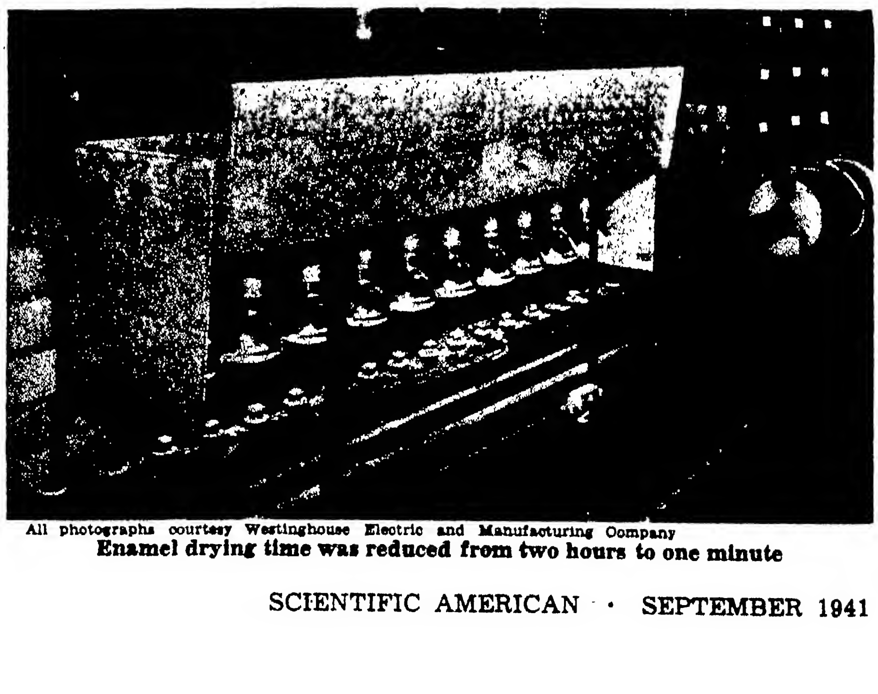
No matter what explanation is given to account for the results when infra-red heating is used, the final and practical answer is to be found in the many applications to which heat lamps have been put and in the satisfaction that they are daily delivering in speeding up production, saving costs, increasing safety by minimizing the explosion and fire hazard of open flame furnaces, and so on.

Although not too much is known about the underlying phenomena of infra-red heating and drying, excellent progress has been made and is still being made, so that practical information on specific applications is rapidly piling up. Because of the empirical status of the art, and because heating and drying requirements vary widely in different applications, engineers recommend that trial installations on a small scale be made before major installations are attempted.* Thus it is possible to determine in advance the number, size, and arrangement of lamps that will give the best results for the service demanded.

As to the lamps themselves: These are, as has been said, of the incandescent type, especially designed to give maximum heat in the usable part of the spectrum, with minimum light. In addition, experiments are being conducted with filters to decrease still further the amount of visible light falling on the work, to expedite inspection of parts during drying or heating. Even though the individual bulbs give relatively little light, the cumulative effect of the large number of bulbs used in the average installation frequently results in too much glare for eye comfort.

The lamps are available in a range of sizes from 250 to 1000 watts, the lower wattage with or without sealed-in reflectors. The self-contained reflector requires no additional equipment other than a

*Interested readers with specific problems in hand that might be solved by infra-red lamp heating installations will be referred to commercial sources of data if they will address the author.



All photographs courtesy Westinghouse Electric and Manufacturing Company

Enamel drying time was reduced from two hours to one minute

socket and a method of mounting. The other type must be used with an external reflector. The conservative operating life of these lamps is stated as being in excess of 5000 hours. They may be operated in any position, bringing to an installation the added advantage of space economy. They may be placed both above and below a horizontal conveyor belt, thus increasing the rapidity of heating by more than 50 percent over other heating installations where only one side may be heated at a time. They may be placed in vertical parallel banks with a vertical conveyor passing between two banks, a method that is impractical with other forms of heating, due to the chimney effect that tends to increase the heat at the top and decrease the heat at the bottom. Since the incandescent filaments are totally enclosed, the fire hazard is low. Where irregularly shaped objects are to be heated or dried, the bulbs may be so placed on their supporting racks as to deliver essentially uniform quantities of energy to all parts of the object.

The design and interior surface of the reflectors used with these lamps have a great bearing on the efficiency of the completed installation. In cases where the surface of the object to be heated is such that it reflects a large part of the rays, the reflectors may be so constructed as to present a continuous surface that reflects once again those rays sent back by the object. In this way loss of useful heat rays is minimized. In installations where reflection from the object is not a factor, separate enclosures may be provided for the individual bulbs.

Engineering data show that, while silver has the highest reflecting power for energy between 6000 and 16,000 Angstroms, such a surface oxidizes so rapidly under operating conditions as to be impractical. Copper, aluminum, and nickel surfaces show up well, but gold plating has characteristics that place it above all others for use in open reflectors. It has a reflecting efficiency of 84 to 97 percent, depending on wavelength, retains its surface characteristics for long periods of time under exacting conditions, and can be cleaned with the strong alkali solutions that must be used to remove the deposits which accumulate on reflectors in some industrial applications.

Thus a principle that is as old as the sun itself is being applied to a wide variety of jobs in industry, speeding operations and cutting costs. That the principle can be reduced to satisfactory practice in a great number of instances is definitely proved; that more applications will come in the future is indicated by the fact that intensive research is still continuing in an effort to improve technique and equipment and to find new uses for infra-red heating.

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For Checking Water Purity

Electrical Equipment Gives Constant Check, Sounds Warning or Automatically Adjusts

NATHAN SCHNOLL
Chief Engineer, Industrial Instruments, Inc.

Since the electrical conductivity of water is largely in proportion to its deviation from the chemically pure state, it becomes feasible to check the purity of water used for various industrial and other applications simply, accurately, by measuring that electrical conductivity. Based on this principle, there have been developed equipment and methods which are now finding use in laboratories, hospitals, and many industries for checking distilled water, steam condensate, boiler feed water, output of water treatment plants, and so on.

Ordinary faucet water contains in solution a sufficient quantity of salts and other conductive substances to make it a fair conductor of electricity. Pure water, contrariwise, is a comparatively poor conductor. Thus the specific conductance of water becomes a positive measure of its purity and a

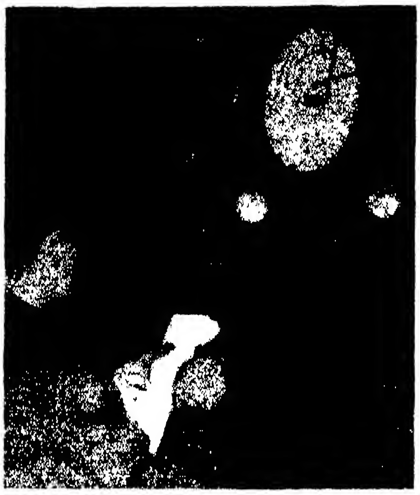
Solu-bridge and dip cell

conductivity measurement, at once simple and satisfactory, appraises its quality.

The conductivity of water obtained directly from a good commercial still in proper adjustment, for example, is on the order of 500,000 ohms per centimeter cube at room temperature. When the water is permitted to remain in contact with containers of metal or glass having even a small degree of solubility in water, the specific resistance of that water will drop to values as low as 200,000 ohms in a comparatively short time. Slight changes in the adjustment of the still may change the quality of the distilled water very markedly. Variations in the still itself, even when the adjustments are maintained constant, produce marked variations in the quality of water obtained, with corresponding changes in the measured resistance of the water. Such variations may be due, for example, to changes in the concentration of impurities in the water of the evaporating chamber.

It is thus seen that a measurement of the conductivity of distilled water may be used as a check on the adjustment and operation of any water still. The very fact that a still is used indicates the necessity for a supply of pure water. Whether the application be for laboratory, hospital, or some industrial use, the conductivity method has been found an invaluable aid towards securing consistently good results. And for the practical application of this method an automatic distilled water and condensate check-

er has been developed which operates in conjunction with a conductivity cell screwed into a standard connection in the pipe line or tank containing the distilled water or condensate. The checker is in a metal cabinet and mounts on a wall. The operating points of the relay, used to control an alarm or the valves, may be set



Typical installation in a boiler room of solu-bridge control unit

for individual requirements by means of an adjustment on the instrument panel. A meter indicates continuously the purity of the distilled water or condensate. An automatic checkup is constantly maintained, and either an alarm is sounded or flashed, or the corrective mechanism is automatically operated, when the conductivity exceeds the set limit.

For other installations, particularly in plants where equipment must be handled by relatively unskilled industrial workers, the "solu-bridge" has been developed. Here is an industrial version of the Wheatstone bridge, in which a simple conductivity or dip cell, in contact with the water or solution, is connected with the bridge. If several stills, vats, tanks or other pieces of equipment are single solu-bridge. The instrument this is achieved by a number of conductivity cells connected through a rotary switch to the single solu-bridge. The instrument has two knobs; one is set for the temperature of the water, condensate, or solution, while the other is adjusted until the circuit is in balance. The reading is then taken from the main dial.

With the solu-bridge, also, a relay may be arranged to control an external gong, light, or other alarm, or to operate a magnetic valve or other corrective mechanism, if automatic operation is desired.

The electrolytic conduction method of checking boiler water is finding favor among operators of steam plants troubled with scale. This method maintains close check on the concentration of solids in boiler feed water and boiler water. When readings exceed a set value, the boiler may be partly drained and fresh water introduced, or the supply can be properly treated.

The solu-bridge is also used to check steam condensate for carry-over of solids and salts that might otherwise cause damage to steam turbine blades or other equipment. A suitable warning calls for blowdown of the boiler.

In the operation of water-treatment equipment, the solu-bridge permits close check on the operation and marked economies in chemicals. The water output can be checked for proper treatment. In the case of Zeolite water-softener equipment, for example, a close check can be kept on the condition of the Zeolite bed which, when in need of regeneration or reactivation, can be so treated immediately. This is more efficient and economical than the usual practice of metering the water output and regenerating or reactivating the bed at a given gallonage.

Another application for conductivity measurements is in connection with surface condensers of steam power plants. The steam condensate in this case is essentially distilled water, with a fairly high specific resistance. The cooling water, however, is generally either ordinary raw water or, in some instances, sea water. A very slight leak of the cooling water into the condenser can be detected immediately by a decrease in the resistivity of the condensed water, and steps taken to correct the trouble that, if allowed to continue, might have serious and costly results.

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For Information on New Products and Processes, See the Section

Industrial Growth

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VANISHING OIL

Designed for Lubricating High-Temperature Bearings

Lubricating oil which does its work, then vanishes without a trace, is now available for solving industrial problems of lubrication at extremely high temperatures. A contradiction in petroleum research which has pointed constantly toward giving lubricants greater endurance and more lasting quality, the new oil, known as Caloria, is the first petroleum lubricant to embody the characteristic of complete disappearance at high temperature. It is designed for lubrication under intense heat, such as is found in kiln cars, glass-making machinery, ceramics and glass molds, annealing and baking ovens, working parts of die casting machines, and various hot parts of machines in the metal industries.

Unlike conventional petroleum lubricants which often begin to break down or crack at 400 degrees, Fahrenheit, and thereby leave a residue of carbon, varnish, and other matter which coats bearings and causes wear and power loss, Caloria is recommended only for temperatures above this where it lubricates and while doing so evaporates completely, leaving the lubricated surfaces absolutely clean. Laying up of equipment for cleaning or replacement of bearings is eliminated, replenishment of the lubricant being all that is required to maintain equipment in service. Extensive field tests have proved that this "vanishing oil" is the solution to hot-spot lubrication.

The new product is available in several viscosities ranging from a light-bodied water-white liquid to a viscous, slightly turbid liquid which requires more than 11 hours for two ounces to flow through the orifice of a viscosity measuring device. Different viscosities are needed to meet varying methods of lubrication under a wide range of conditions.

In addition to its ability to disappear completely under high heat, Caloria has another unusual characteristic. Conventional oils spread over many hundred times their original area when dropped on a surface heated to 400 degrees. Caloria spreads to only four or five times its original area, assuring that it will remain in greater quantity

and for a longer time on bearing surfaces under high heat.

The amount of time required for all of the Caloria in a bearing to disappear depends upon the amount used, the surface area to be lubricated, the time the oil is in contact with the surface, and the bearing temperature. Replenishing may be regulated accordingly.

For use in cases where Caloria cannot be re-applied before complete evaporation takes place, as in some kiln car bearings, the use of Van Caloria, which incorporates colloidal graphite, will cause a dust-thin layer of graphite to remain on the bearings after complete disappearance of the petroleum lubricant. The graphite will prevent metal-to-metal contact until a new supply of Van Caloria reaches the bearings.

SALVAGE

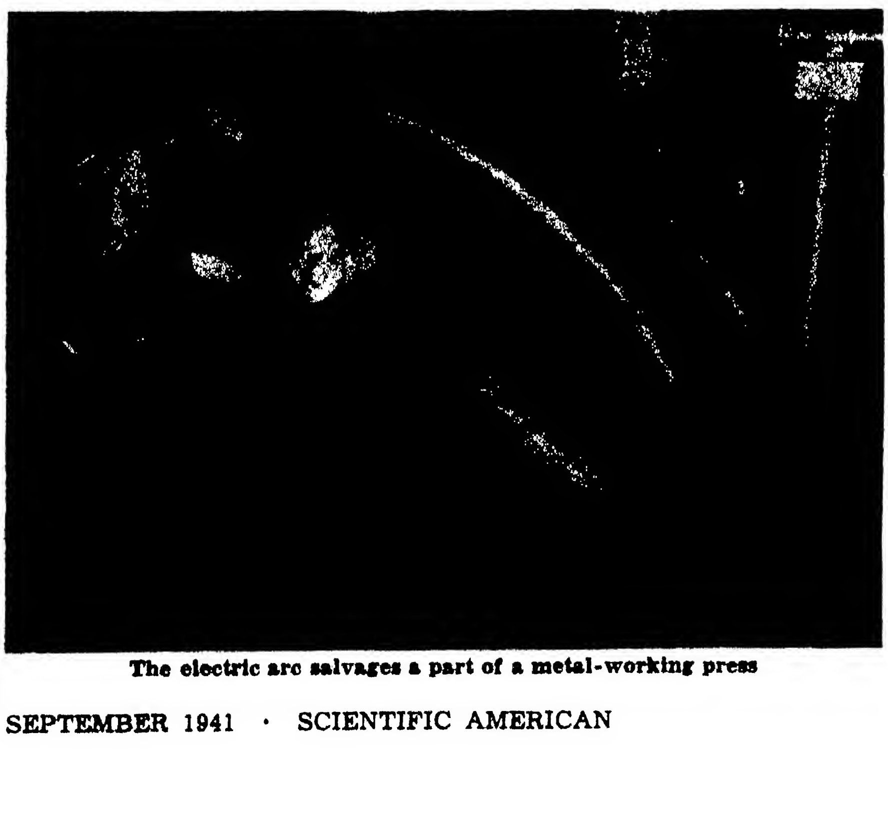
Welding Processes Reclaim Equipment

Methods of welding metals—by both the electric arc and oxy-acetylene processes—are playing important parts in the salvage of worn or broken machinery and other equipment.

According to a study of statistics covering 21 pieces of equipment salvaged by arc welding, made by the James F. Lincoln Arc Welding Foundation, the average salvage cost was only 22.3 percent of replacement cost.

One striking example of arc welding salvage, obtained from the machine-tool industry, was the repair of the frame for a metal-working press. It would have required 10 to 12 weeks to replace this press, whereas it was repaired by welding in 56 hours and at only 10 percent of the replacement cost. In another case the frame for a metal-stamping press was repaired by welding in 5½ days.

How welding was used to repair cylinder walls in ship power plants without removing engines. *Below:* General view of a welder at work. *Above:* Welding into place a cast section shaped to fit the break. *Above, left:* A completed weld after boring



The electric arc salvages a part of a metal-working press

Added advantages of salvage by welding, of particular importance to national defense industries, is the possible reconditioning for immediate service of production machines and equipment now idle because of inability to obtain replacement parts. Delays in obtaining new machine tools and replacement parts, for example, range from 90 days up to one year, whereas even serious damage can be corrected in a matter of hours by welding; the repaired machine could then be continued in operation until the new equipment is delivered, if replacement, for any reason, seems desirable.

An outstanding example of salvage by oxy-acetylene welding is the repair work which is being done on the main engines and other vital parts of the foreign cargo vessels which the United States government took over last April. Repair work on these ships, according to The Linde Air Products Company, is being speeded up to a point where a number of them will soon be back in service.

In three of the accompanying photographs are shown stages of oxy-acetylene repair work on the main engines of two Italian freighters. The bronze-welding was accomplished without the necessity for removing these engines from the ships.

On each ship, U-shaped sections had been broken out of the walls of the intermediate pressure cylinders. New sections, cast to fit the contour of the breaks, were bronze-welded in place and then finished off to make a perfect repair.

PAINT SAVING

Thousands of Gallons Reclaimed Annually

Seven years ago a group of employes in the Westinghouse Merchandising Division Works at Mansfield gave C. L. Van Derau, Works Manager, a tip which led to


Unused paint falls into vats, is salvaged for further use

a "million dollar" idea. Ranges, refrigerators, and other electrical appliances manufactured in the plant are painted with spray guns. About half of the costly finish was being lost to the walls and floors of the painting shops. The employes obtained permission to try some of the waste paint for their spring house decorating. They reported that it was "swell" for painting interior woodwork.

"Why not put a stop to paint losses?" asked Mr. Van Derau. He and his staff went to work on the problem. Last year 60,000 gallons of paint, about 95 percent of the amount which "missed" in the spraying operation, were reclaimed. The paint is processed in a specially designed reclaiming apparatus presided over by a graduate chemist. It emerges pure and durable, suitable for many utility paint jobs and for maintenance work in the company's manufacturing divisions.

PLASTIC FILLER

Inexpensive By-Product Gives Satisfactory Results

The search for new types of plastic has resulted in the use of cottonseed hulls, a very cheap by-product of the cottonseed oil mills. In a paper read before the American Society of Mechanical Engineers, Professor R. W. Morton has described some of the several new applications.

The plastic compound contains 60 percent of cotton hulls when used for regular plastic, 85 percent when used for tile, and 95 percent when used for wallboard. The relatively large quantity of hull filler used greatly reduces the amount of chemical binder necessary, and this fact should materially reduce the cost of production of the finished plastic. The plastic is of the thermosetting type. Products are formed at a pressure of 3000 pounds per square inch and a temperature of 310 degrees, Fahrenheit, in 1½ minutes, and possess hard polished surfaces.—*Plastics* (London).

MAN-MADE RUBBER

Advantages and Disadvantages in Commercial Use

In the first detailed scientific "box score" ever issued on the specific characteristics of synthetic rubber, the B. F. Goodrich Company recently disclosed that the man-made product excels natural rubber in four important service properties, equals it in six, and is only slightly below natural standards in three.

"The results of a year of intensive testing show that Ameripol, the synthetic rubber created from petroleum, soap, natural gas, and air, can go to bat for natural rubber 769 out of 1000 times in the broad field of mechanical rubber goods," declared V. I. Montenyohl, vice-president in charge of the company's synthetics manufacture.

In various compounded states, the synthetic is already being widely used in airplane de-icers, aviation and gasoline hose, and in many mechanical applications where it is in contact with acids, oil and grease, benzol, and carbon tetrachloride.

The tests showed that the synthetic substance excels natural rubber in its resistance to aging, oxidation, heat, and oil, four mortal enemies of nature's product. It equals natural rubber in range of hardness, elongation, tensile strength, permanent set, and in resistance to abrasion, acids, and alkalies, and is only slightly below natural standards in elasticity, tear resistance, and reaction to subfreezing temperatures, and even these can be remedied by skilful compounding, Mr. Montenyohl stated.

Very similar in appearance to natural crude rubber, Ameripol can be tubed, calendered, frictioned, spread, milled, and vulcanized just like natural rubber. Special cements have been developed which will permit vulcanization and adhesion to metals, including brass, provided the metals can be suitably roughened by sand- or shot-blasting.

Resistance to mineral, animal, and vegetable oils and fats, to the oxidizing influence of the metallic soaps used as driers in paints and inks, to heat, and to abrasion particularly in the presence of oil, are among the most valuable fundamental properties of the synthetic product.

Ameripol compounds can be made in the same hardness range as those of natural rubber, and elongation is also about the same. Tensile strengths can be varied by the materials used in compounding. Best quality compounds are obtained with black pigments. They have a faint, pleasant odor. Special compounds are made nearly odorless and tasteless.

Tear resistance of the best Ameripol compounds is somewhat lower than the best compounds of natural rubber, while abrasion resistance under normal conditions is about the same, although at high temperatures and in the presence of oils the synthetic product is considerably superior in abrasion resistance. Swelling and shrinkage of the synthetic in the presence of petroleum products is less than that of compounds of natural rubber.

INDUSTRIAL TRENDS

WHAT ABOUT THE MOTOR CAR?

Disregarding for the moment whatever curtailment in unit production will take place in the motor-car industry as a result of national defense requirements —latest figure on curtailment at the time of writing is 50 percent—there are certain other factors that stem from the same source and which will definitely affect the trend of the automotive industry at least "for the duration." And since these trends will be more or less apparent in the cars that the public will be buying for some time to come, they are of compelling interest to the man-in-the-street as well as to industry at large.

Published rumors have it that "ersatz" materials, forced upon the motor-car industry by inescapable conditions, will result in lowered quality, impaired efficiency. Such a trend would be the easy way out of a difficult situation, but the ingenuity that has made American industry synonomous with material progress just doesn't work that way and, unless present indications are completely erroneous, it won't start to work that way now.

Pioneer in the automotive industry, the Ford Motor Company may safely be considered spokesman for the entire field of motor-car producers. Thus when a Ford representative recently denied emphatically that inferior materials will be used as substitutes for strategic metals, it can be taken for granted that the same will hold true throughout the industry. Substitutes—yes; inferior materials—no. Higher production costs—yes. Lowered efficiency—no.

The manufacturer's representative put it this way: "The thing I want to stress is that we very definitely will not build an 'ersatz' car made up of inferior materials. The cars will cost us slightly more to build and will be slightly heavier, but the owner would never know the difference as far as performance and operation of his car are concerned."

That, briefly, is Ford's answer. And here's about how it works out. Many of the parts that now use zinc, aluminum, and nickel will be replaced by parts of iron and plastics. In many cases the weights of various parts will be increased by the substitutions and in some instances re-design of parts has been necessary to keep efficiency up to standard. The total weight increase, however, according to Ford, will not be great enough to affect gasoline consumption in the least.

Specific cases that prove the point are such items as carburetor bowls and engine valves. The bowls have for some time been made of zinc, produced by the die-casting process. These are now to be changed to cast iron. The substitute is, of course, cheaper in raw material cost but will do the job just as well. The Ethiopian in the stock pile is that the bowl made of the cheaper material will be higher in final production cost. This is brought about by the increased time needed for machining a cast-iron bowl, as compared with one made of zinc. In the case of valves, it is found that the nickel which increases the "hot strength" of the valves will no longer be used. It has been possible, however, to change the design of the valves in such a way that the new valves, which would be considered inferior under former standards of design, will be as satisfactory in service as those containing nickel.

So it will go in many other parts of the motor-car produced in the United States during World War II. Plastics will replace metal in such parts as instrument panels, cast iron will be more widely employed, engineering ingenuity will find new ways of doing old jobs with other materials, and the net result will be that Americans will still be able to buy motor-cars that, while available in limited numbers as dictated by the industrial requirements of national defense, will undoubtedly still be superior in every respect to any that are made anywhere else in the world.

THE PART THAT PLASTICS PLAY

Touched upon lightly in the foregoing paragraphs was plastics' place as a substitute material in motor-car manufacture. But substitution is only one of the roles that plastics play in that industrial theater; they have other important parts which they fulfil best because of their own inherent characteristics. And, the motor-car being what it is in the over-all picture of American industry, these roles are of particular importance to all those who follow the progress which plastics are making in so many fields of endeavor.

A recent survey of the major motor-car manufacturing plants resulted in the construction, on paper, of composite cars in which were embodied the plastic parts used by the manufacturers represented. In the 1941 composite model were a total of 110 components; in the 1942 models this number will increase to 120. Obviously, all these uses for plastics do not come as a result of the scarcity of certain metals; plastics themselves have desirable qualities of durability, beauty, colors of many hues, light weight, and economy.

Thus plastics are to be found in motor-cars in uses ranging from radiator ornaments to tail and stop-light lenses, from the "meat" in safety-glass sandwiches to accelerator pedals, from name plates to horn buttons. The acrylic resins are being widely employed for their "light piping" qualities, bringing easier-to-read instruments and an absence of glare to the instrument panel which, itself, as noted before, may be of plastic.

Much has been said about the possibility of fabricating bodies from plastics. Automobile engineers, however, warn against over-optimism in this respect, and do not predict an early solution to the problem of molding large body panels from these materials. In any event, car manufacturers are continuing active research on applications of plastics to their problems.

FM-AM COMBINATION

A new radio tube developed by Philco makes possible a receiving circuit that responds to both standard and frequency-modulation transmitters, a job that formerly required two sets of tubes in the receiver. Here, undoubtedly, is the beginning of a trend in the radio industry toward combination receivers at reasonable prices, triggered off by Philco's announcement of a model selling in the neighborhood of 50 dollars.

—The Editors

The Sun's Faint Edge

How Three Dutch Astronomers Verified a Theory of the Sun with Simple Apparatus

HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astromony and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

THERE are still many kinds of astronomical observation which may profitably be made with small and relatively inexpensive instruments; but it is rarely that this can be done in the case of a total eclipse of the Sun. When large sums have to be spent to transport the observers to a station where the whole time available for observing hardly ever exceeds five minutes, it is sound scientific management to use powerful and nearly automatic apparatus which will make, during the precious seconds, a series of photographs upon which months of measurement and calculation may be well spent. But devices which satisfy this essential requirement need not always be costly. A remarkably pretty example to the contrary has just come to hand. The observations were made during the Russian eclipse of 1936, and published, with full discussion, in Holland in April, 1940. But it is only within a few weeks, when a long file of copies of the *Bulletin of the Astronomical Institutes of the Netherlands* reached this country, that we knew the results.

It has been known for a long time that the center of the Sun's disk appears much brighter than the edge. We do not notice this when we look at the Sun directly through smoked glass; for the edge, contrasted with the dark sky outside, looks brighter than it really is. But when a magnified image of the Sun is projected upon a white screen held a foot or two behind the eyepiece of even a very small telescope, the fading toward the limb is conspicuous. The edge is not only fainter than the middle, but different in color, looking reddish-brown instead of white.

With a large solar image, such as is given by a modern tower telescope, it is possible to measure with accuracy the way in which the light of any specified color falls off from the center to the limb, and it is found that the graph of the variation is gently rounded near the middle, and drops off very steeply at the edge. Up to 95, or even 98 percent of the way, measures are fairly easy. But, close to the edge, great trouble comes from bad seeing. The unsteadiness and "boiling" of the image, arising from irregularities in refraction in our atmosphere, is at its worst for observations of the Sun, whose heat causes all sorts of air-currents. When we have set the slit of our apparatus on what would be, with a steady image, 99½ percent of the way to the edge, the dancing of the image may at one moment bring on a brighter region, farther in, and at the next it may shift the Sun clear off the slit. The average effect will be a smeared mixture which does not accurately represent any particular point on the Sun's disk. The best chance of escaping this difficulty is to observe the intensity of sunlight during the partial phases of a total solar eclipse. Shortly before totality, when but a narrow crescent of the photosphere remains in sight, all the light which reaches us comes from near the limb, and, as the eclipse advances, it is the very edge which sends us light longest. Bad seeing may distort the image of the solar crescent, but will not affect the whole amount of light which we get from it.

HENCE an accurate light-curve, showing the changes in the last five minutes before and after totality, should provide the data for a solution of the problem. At any given instant, the light received comes from an arc of a certain length along the very edge, a shorter arc 1 percent of the way toward the center, and so on. To "unscramble" the effects of this mixture is a purely mathematical problem, which costs some algebra and arithmetic, but is no real obstacle. The real problem is to get as long a series as possible of good measures of the intensity of sunlight, precisely timed, during the critical minutes.

Our Dutch colleagues, Messrs. Ferwerda, Uitterdijk and Wesselink, solved the first part by taking their photographs with "amateur movie cameras" of a standard make, at the rate of 16 per second.

Timing was provided by two small electric lamps in the field of view, one flashing regularly at intervals of a second, the other at irregular intervals as a key was pressed. Both circuits were recorded on a chronograph, and the time of any exposure was thus determined to about a hundredth of a second.

OBSERVATIONS of the Sun were made upon its reflections in a series of small convex mirrors—set up on the board which carried the lamps. There were ten mirrors (ordinary spectacle lenses aluminized on the convex side) with radii of curvature ranging from seven feet to about an inch. Each mirror, viewed directly with the eye, would show a small image of the solar crescent—smaller of course the more curved the surface was—whose apparent size can easily be calculated by geometrical optics. The cameras were purposely set a little out of focus so that all ten of the reflected images appeared as circles of the same size —1/75 of an inch in diameter—much bigger than the geometrical images of even the largest reflected crescents would have been in focus.

The geometrical images would be of different sizes, but all of the same surface brightness. When expanded to extra-focal disks, they are of the same size, but very different brightness—the whole range from mirror 1 to mirror 10 being nearly 1200-fold. The relative brightness of these images could be simply and exactly calculated.

When the movie cameras were started, two minutes before totality, the sunlight was fairly bright. The images from the less-curved mirrors were hopelessly over-exposed; that from the most curved (No. 10) was too faint to be used, but mirror No. 8 gave a properly exposed image, neither too black nor too thin. As the light diminished, and this image grew too faint, image No. 7 was well-ex-

posed, and so on, until, just before totality, only No. 2 could be used.

In this way, without shifting anything, or interfering with the steady running of the spring-driven movie mechanism, it was possible to secure at least one properly exposed image, and often two from neighboring mirrors, while the intensity of the light fell from about 1/100 to less than 1/10,000 of that of the unobscured Sun. Two cameras were used, with color-filters, one working with blue light ($\lambda 4540$) and the other with yellow-green ($\lambda 5670$).

The 90 seconds of totality gave time to substitute two new movie cameras (and, we may hope, for a glimpse of the eclipse) and then as the Sun emerged, the whole process was repeated in the increasing light.

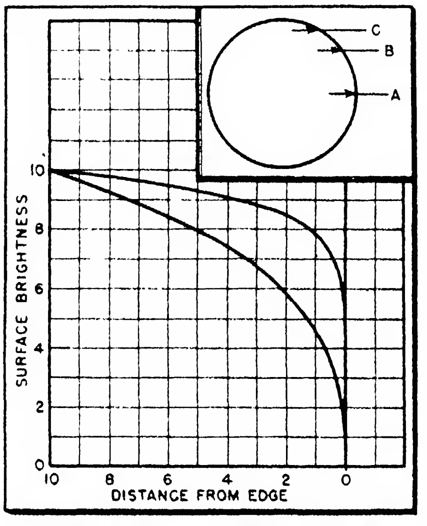
The apparatus was set up at Beloretchenskaia, in "the northwestern outskirts of the Caucasus," and worked perfectly on the day of the eclipse. The one uncontrollable factor—the weather—was unkind. Thin wisps of cloud drifted across the Sun at times. These would have done no great harm to spectroscopic observations; but the thinnest cloud plays havoc with photometric work. The plates were nevertheless measured—a matter of 30,000 settings to determine the degree of blackening of the available images—and the results worked up.

It appeared that the clouds had been bad after totality, and for part of the time before it. But, for a vitally important minute just before the Sun disappeared, and for ten precious seconds after it came out, the sky was practically clear, and good results were secured, covering a decrease of five magnitudes in the light.

Two unexpected results stand out clearly from these observations. First, during the last minute, though the light was reduced to 1 percent of its initial value, it maintained exactly the same color. The observations in the blue and yellow give exactly the same curve. Second, there was more light left, when only a very narrow sliver of the Sun remained, than would have been supposed from previous measures of the brightness farther from the edge of the disk.

The analytical discussion which our authors give of their measures, though as ingenious and pretty, in its way, as their instrumental inventions, would be less interesting here. Suffice it to say that they got an excellent representation of their data by the assumption that the surface brightness for points close to the edge of the Sun varies as the tenth root of the apparent distance from the edge.

This is illustrated by the upper curve in the graph. Passing from a given distance from the edge to one tenth as much, the surface brightness falls only 20 percent, and the drop at the actual limb is practically (though not mathematically) perpendicular. The older measures show that, farther inside,



Curves of Sun's brightness near edge. (Insert: The explanation)

the brightness changes about as the cube root of the distance from the edge (as illustrated by the lower curve).

The observations are accurate enough to show that the change in brightness must follow very nearly the upper curve. The assumption of uniform brightness—which would give a horizontal line followed by a vertical drop—is wildly inconsistent with the measures.

So far these results may appear less interesting than the way in which they were found. But their interpretation is more noteworthy.

It has been realized for a long time that the change in brightness and color toward the Sun's limb depends upon two things. First, the Sun's surface is not solid, but composed of gas full of thin incandescent haze. Second, this gas grows hotter as the depth increases.

The corner insert in the illustration (which is very far indeed from being drawn to scale) illustrates what happens. It represents the Sun—the Earth being far away on the right. Consider first a ray *A* which appears to come from near the center of the disk. It will carry light from deep layers, greatly weakened by passage through the overlying haze, from intermediate layers, moderately weakened, and from superficial layers, hardly weakened at all. On the average, we can treat it (closely enough for our purpose) as if it all came from a certain properly chosen average depth, as shown by the arrow. For a ray emerging obliquely at *B* the amount of haze lying above the average depth will be about the same—but this amount must be measured along the slanting path of the rays, so that, on the average, the light comes from a smaller depth below the surface. For the more oblique ray *C* the effective average depth will be still smaller.

Hence the light at *A* will come on the average from hotter layers than that from *B*, and still more, compared with *C*. Light from a cooler source is weaker and redder; hence the Sun's disk will be brightest and bluest at the center and grow fainter and redder toward the limb.

From the regions extremely near the limb, which were studied in the eclipse observations, the light escapes at a very small angle to the surface, and the effective depth is also very small. For these almost grazing paths the light is very little fainter, and not perceptibly redder, from the very uppermost layer than from those a little below. The meaning of this is clear—the drop in temperature, which continues steadily, from the deepest layers we can study directly, almost to the top, must finally level off very near the "surface," (that is, the level at which the solar gases cease to be perceptibly hazy).

Why this should happen is not yet explained, but evidence that it does has been derived by two other investigators in different ways. Professor H. H. Plaskett, studying the distribution of surface brightness farther from the edge, finds that it can be interpreted only by the same hypothesis of an almost isothermal layer; and Miss M. G. Adam of Oxford has shown that this will also explain the otherwise puzzling fact that, though the strong lines of the solar spectrum are weakened at the limb, the faint lines are strengthened there. It is remarkable that a simple proof of the same thing has been obtained with no more unfamiliar apparatus than movie-cameras, spectacle-lenses, and flashing light bulbs.

Telltale Tracks

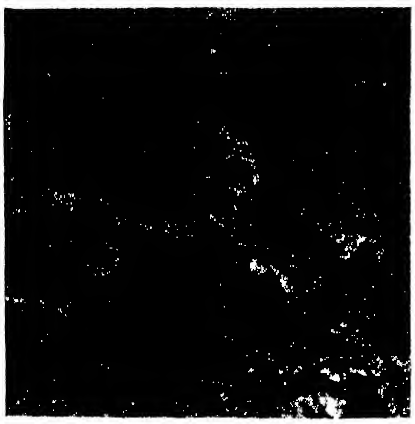
Human Footprints in Hardened Rock in Central America Reveal a Dramatic Flight

AN ARCHEOLOGICAL discovery which promises to be of the utmost significance—footprints in rock of persons fleeing from a volcanic eruption 2000 to 5000 years ago—has been made by an archeologist of the Carnegie Institution of Washington on the outskirts of the city of Managua in Nicaragua.

Aside from the dramatic story told by these footprints, they constitute the earliest known evidence of human beings in Central America, where the most advanced of New World cultures were to arise many centuries later.

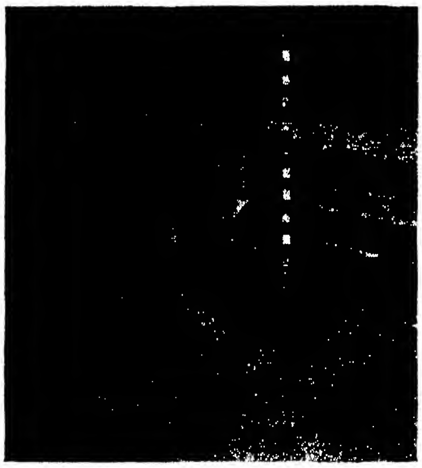
The prints were made in a layer of volcanic mud while it still was soft, probably within a few hours after it covered the area. There is some evidence that cinders from a nearby volcano were raining on the heads of the people as they fled.

The site was found by F. B Richardson of the Carnegie Institution staff and was inspected shortly afterward by Dr. A. V. Kidder, head of the Institution's Division of Historical Research. Impressed by the significance of the discovery, Dr. Kidder asked Dr. Howel Williams, volcano expert of the University of California, to fly to Managua.



Man tracks and deer tracks

It was found that over a deposit of volcanic ash of unknown age and depth there had been laid down about six inches of volcanic mud in which the footprints had been made. Above this stratum there has accumulated several subsequent deposits of volcanic origin to a total depth of about eight feet. President Samosa, keenly interested, at once acquired the land for the government.



Footprints and later strata

The footprints are of two individuals walking on fairly firm material and a number of others who were crossing mud so soft that their feet sank in it. Either just before or just after the humans crossed, a large deer, running at right angles to them, left his hoofprints in the mud.

THE INDIVIDUALS were fairly small people, to judge from the size of their feet. They appear to have been going toward a nearby lake to escape an eruption. Quarrymen say that all the footprints they have uncovered in the past were turned in the same direction.

Before the footprints were made there probably had been millions of years of volcanic activity in the neighborhood, since the prints are underlain by hundreds of feet of ash. It may be that, just before the prints were formed, the volcanic craters a short distance from the present city burst into unusually violent eruption, causing mud flows—known to volcanologists as "lahars"—to sweep down over the plains around Managua. They may have been formed because of temporary blocking of the rivers that drain from the highlands to the south. They are remarkably like those which buried the Roman city of Herculaneum in 79 A.D.

Footprints hardened in the rock

Such flows harden very quickly—a somewhat similar deposit was laid down on the slopes of Lassen Peak in California in 1915 and within a few hours it was difficult to stamp an impression in it with the feet.

Very shortly after the prints were made—perhaps simultaneously—they were covered by a thin veneer of black cinders. Then followed another mud flow, another eruption of black cinders, and then a rapid succession of thick mud flows. These hardened to rock, and a quiet interval followed, during which a river cut a channel through the layers of rock and deep into the underlying deposits.

Subsequently, a distant volcano threw out showers of white pumice. This piled up to depths of more than a foot. There was another long period of quiet. Rivers cut new channels through the pumice. Elsewhere a top soil about a yard thick was built up. Renewed eruptions covered this soil with ash. Another soil, in some places ten inches thick, accumulated. Finally the topmost layer of soil was laid down.

It required a long time for these four layers of soil to be accumulated and a deep river channel to be cut. About the shortest possible lapse of time from the day of the footprints is 2000 years. It may easily be about twice that long. Further study next winter is expected to shed more light on this.

The Silver Clamp

Experiments in Progress Give Some Promise of a Remedy for High Blood Pressure Ills

BARCLAY MOON NEWMAN

AT LAST the kidney has been definitely incriminated in the mystery of persistent high blood pressure, known to medical men as hypertension or, more accurately, "essential hypertension," and hitherto of unknown cause. Hence medical science for the first time has a substantial basis for hope of therapeutic progress in what is known as the physician's most difficult problem: degenerating heart, blood-vessels, and kidneys. For such degenerations are generally associated. Together, these ills carry off one of every two individuals past 50 in the United States.

In 1836, Richard Bright set certain facts and a theory before the medical world. It was he who pointed out that a significant percentage of those who have chronic kidney diseases also have circulatory trouble and, especially, a pathologically enlarged heart—that is, a heart that becomes enlarged because it is overworked; and overworked for a reason that remained mysterious. Bright further pointed out that in autopsies of such cases only minor changes are to be found outside the kidneys—changes that do not in themselves provide adequate explanation of the enlargement of the heart. He asked: "What, then, is the cause of the unusual efforts to which the heart is impelled?" And he theorized: "Something so affects the minute and capillary circulation as to render greater action necessary to force the blood through the distant subdivisions of the vascular system."

Thus Bright put forth the conception of the heart working against increased pressure, caused by increased resistance to the flow of blood through the lesser blood vessels. He went on to ascribe the origin of the increased resistance and pressure to kidney disease. This suspicion of the kidneys was justified by the degenerations found in them at autopsy and by the very frequent association of heart conditions with kidney upsets.

So, more than a century ago, Bright posed another question: "In kidney failure is there not to be discovered a great source of circulatory failure?"

He had no way of measuring blood pressure, and did not know definitely that chronic elevation of blood pressure accompanies a large percentage of chronic kidney conditions—though his keen investigations provided him with ample hints. Extensive blood pressure measurements of any sort have been made only since well into the first decade of the present century. Through rare precision of observation, and through rare clarity of judgment, which enabled him to see meaning in details that were meaningless to contemporaries, Bright led the way toward eventual effective measures against the greatest killers of mankind — heart-blood-vessel-kidney disorders.

AFTER Bright, investigators lost themselves in the countless enigmas and apparent contradictions of such research. Nevertheless, year by year, it was becoming obvious that disturbance of heart or blood-vessels or kidney did disturb the whole heart-blood-vessel-kidney system. Thus this trio slowly attained the title among medical men of "cardio-vascular-renal." Ever more striking statistics disclosed the intimate if not causal relationship of advancing age and increasing failures of heart, blood-vessels, and kidneys. The high frequency of pathological, or diseased changes in the blood vessels of the kidneys studied at autopsy of high blood pressure cases forced deeper thought.

In 1928, Dr. Harry Goldblatt, of Cleveland, had become convinced that one of the world's fundamental secrets was given hint of by the frequency of association of kidney blood-vessel degeneration with high blood pressure, or essential hypertension, and he began to test the century-old theory of Richard Bright.

As is obvious from the century-long puzzlement, many lines of thought were possible. Goldblatt had the acumen to pick the essential line. Thus he pondered: "What will happen if you imitate the apparent condition in hypertension by reducing the blood supply to the kidney? The man or woman with essential hypertension usually has narrowed blood-vessels in the kidney. Will the dog used in the laboratory experiments develop persistent high blood pressure if experimental narrowing of kidney arteries and consequent reduced blood flow to the kidneys can be brought about?"

Four years of effort were required before the extremely delicate experimental technique could be worked out and the first studies reported. Because he knew of no way of narrowing all the vessels in the kidney, Goldblatt set himself the problem of narrowing the main artery to a kidney. This, he reasoned, should produce the same effect. The solution to his problem came through the invention of an ingenious silver clamp, so constructed that all degrees of narrowing can be accomplished, and the clamp left on the vessel permanently, or removed later, according to the desire of the experimenter.

In 1932, Goldblatt and his associates gave their preliminary answer to Bright's question: Indeed the kidney can be a great source of circulatory failure. Narrowing of the artery leading to only one kidney, in the dogs used in the experiments, caused hypertension which lasted in several cases for months. The next logical step, narrowing of both main arteries leading to the kidneys, brought a great discovery. For experimental purposes, the counterpart of essential hypertension in man can be produced experimentally in the dog. The dog's blood pressure can be maintained at an abnormal level for years.

The silver clamp was applied to monkeys, nearer kin to man—success again!

Next came the most important finding of all. When the clamping

of the arteries leading to the kidneys was made moderate, high blood pressure developed, but without detectable injury to the function of the kidneys. Thus, as in the so-called benign form of essential hypertension in man, an ordinary clinical examination would not have incriminated the kidneys as the cause of the trouble. This is why, in the past, medical men have been unwilling to accept the idea that the kidney could be the cause of this form of human hypertension.

IN HUMAN beings, sometimes the persistent hypertension suddenly shifts into a more malign form that speedily kills, as opposed to the insidious progress of the benign type. In dog and monkey, the counterpart of the malign type of hypertension, with accompanying marked kidney damage, can be readily brought on—as the silver clamps are screwed tighter and tighter, until the arterial tubes are nearly closed. In this type, kidney function is also damaged, hence it is easier to accept the fact that the source of the trouble lies in the kidney. All grades of the hypertensive condition can be produced, according to the constriction of the clamps.

When narrowing of one renal—that is, kidney—artery has caused hypertension, release of the clamp or removal of the kidney is followed by a drop of blood pressure to normal. Soon, application of this discovery was successful in the clinic. It was recognized for the first time that patients can also have high blood pressure caused by the reduction of blood flow through *one* kidney, and that they may speedily show a return of blood pressure to normal if the diseased kidney is removed. Of course, death follows removal of both kidneys, hence other therapeutic measures must be devised for treating the more frequent condition in which both kidneys are involved; these amazing measures appear to be on the way.

Again the work of Goldblatt and his collaborators pointed the way; they concluded, as a result of various experiments, that a chemical from the kidney, which they called "the hypothetical effective substance," was responsible for the rise of blood pressure which follows the clamping of the artery leading to the kidneys.

A recent report on this phase of the problem, yet to be fully confirmed, is that of Doctors Arthur Grollman, J. R. Williams Jr., and Tinsley R. Harrison, of the Medical Schools of Johns Hopkins and Vanderbilt Universities: "The abnormal kidney may liberate some substance which plays a part in causing hypertension—but the amount of normal renal tissue present in the body also determines whether or not hypertension occurs. We have prepared renal extracts which are capable of reducing the blood pressure of animals with experimental hypertension. Further evidence, however, is necessary before it can be established that the principle present in our extracts is a normal physiological constituent of the kidney, the absence of which is responsible for the development of hypertension."

The preparations made from animal kidneys by these experimenters, and by Dr. Irvine Page of the Indianapolis City Hospital, have been used in a very few cases of hypertension in man—and with excellent results in some. But the pioneers themselves point out that it will be long before any such impure product can be purified and made generally available.

If it should turn out, as this report indicates, that the kidney plays a part in the maintenance of normal blood pressure, as well as in causing high blood pressure, the contribution of the silver clamp to our knowledge of blood pressure will be high indeed. Such a discovery would be even more fundamental than the new knowledge of the old theory of Bright.

Meanwhile, the mechanisms that are set to deadly work by reduction of blood supply to the kidneys are the focus of attention on the part of those who pursue the secrets of essential hypertension. The kidney, with blood supply reduced, is widely believed to manufacture a weird chemical which brings about body-wide narrowing of the lesser blood-vessels. The heart then must work against the resistance brought about by this narrowing, and becomes enlarged. There is no evidence, however, that the higher pressure of the blood is a cause of ordinary arteriosclerosis—that is degeneration and hardening of the arteries. Quite the contrary. According to Goldblatt, the arteriosclerosis comes first, and, when it involves the kidneys, the hypertension follows. The cause of the arteriosclerosis is still an enigma.

Yet, here again, Goldblatt and his co-workers have made an important contribution, for they have shown that in the malign type of hypertension, at least in animals, profound changes develop in the small blood-vessels in many parts of the body, as also happens in the corresponding type of hypertension in man. But this is not ordinary arteriosclerosis, and they believe that the cause of this change in the blood-vessels is the hypertension and the damage to the functions of the kidneys which result in some chemical factor which gets into the blood. Both factors play an important part in bringing about these extraordinary changes in the blood-vessels.

The precise nature of the chemical agent manufactured by the kidney is under the most painstaking investigation, but it seems that the trapping of the deadly molecule of it will be an enormous labor; it is probably produced in exceedingly small quantities, and can thus elude all present methods of isolation.

At least medical science has in this vast problem won its way to the point where the view can be seriously entertained that most cases of essential hypertension in man are not different from experimental renal hypertension in animals.

Alfred Blalock, distinguished experimenter of the department of surgery, Vanderbilt University, Nashville, who has recently reviewed more than 200 scientific reports on experimental hypertension, concludes:

"Granting that there are some types of hypertension which are non-renal in origin, the evidence which has been reviewed indicates that most instances of experimental and probably of clinical hypertension are related to some abnormality in function of the kidneys."

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FORESTALLMENT

Epileptic Fits Deliberately Produced Electrically

VACCINATION against epileptic fits, so to speak, to protect both public and patient against sudden seizures in traffic, at work, and under other dangerous conditions, is about ready for practical use.

The epileptics are literally shocked through the brain, elec-

trically, deliberately, into seizures, but these occur safely in the privacy of a physician's office.

Dr. Lothar Kalinowsky and Dr. Foster Kennedy, New York psychiatrists, have suggested this new method to the American Neurological Association. It upsets ideas physicians have had about this disease, reports *Science Service.*

Shocks of over 100 volts are administered to the brains of patients. This electric shock treatment is identical with that used in treating schizophrenia (dementia praecox). Dr. Kalinowsky originally introduced in this country this other electric shock treatment.

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SIGHT—More than 20 percent of draft-age men are being barred from military service because of defective eye sight. Lighting engineers ascribe this fact largely to poor lighting conditions in homes and classrooms.

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ASTHMA

Old-Fashioned Croup Remedy For Asthma Attacks

SIRUP of ipecac, which children of grandmother's time were given for attacks of croup but which modern physicians have abandoned, gives better results in some severe asthma attacks in children than any modern medicines, Dr. Bret Ratner, of New York, recently told the American Association for the Study of Allergy, reports *Science Service.*

He advised it for children in asthmatic attacks due to obstruction of the small endings of the bronchial tubes. These attacks, he finds from guinea-pig studies, are generally caused by allergy due to substances that are inhaled, such as horse dander, dust, or pollen. The vomiting induced by the ipecac helps the child dislodge the plug that has been obstructing the bronchioles.

The modern remedy, adrenalin, extracted from the adrenal glands, "works like a charm" in severe asthma attacks of another type in which food proteins to which the child is allergic reach the bronchioles via the blood stream and cause spasm. Adrenalin should be given to these children in small doses, he stressed. If the small doses do not help, larger ones will not either, and the physician is advised to try ipecac. Large doses of adrenalin, he pointed out, only increase the feeling of impending doom which the patient, gasping for breath in a severe asthma attack, already feels badly enough.

SUNLAMP

Self-Reflecting, Operates In Ordinary Sockets

EXTERNAL control devices are unnecessary with a new type of sunlamp which fits into an ordinary house socket and produces radiations similar to that of midday, mid-summer sunshine. This new lamp, developed by General Electric, consumes 275 watts and operates on 110-125 volt, 50-60 cycle circuits.

Self-contained

Built into the all-glass hermetically sealed unit are the ballast control, reflector, and elements for producing ultra violet and infrared radiations. The light generator is of the mercury arc type, combined with a special tungsten filament designed to control the operation of the arc.

Engineers estimate that this new bulb has a life sufficiently long to permit more than 400 average exposures.

INSEMINATION

Nearly 10,000 Human Offspring by Proxy

A RECORD of nearly 10,000 American children brought into the world with the aid of the proxy-father procedure —. technically termed artificial insemination — is reported by Dr. Frances I. Seymour and Dr. Alfred Koerner, of New York City, in the *Journal of the American Medical Association.*

The central and Atlantic seaboard sections of the United States have the greatest number of children sired by artificial insemination. Donors were used successfully in 3649 of the 9489 pregnancies.

More than 97 percent of all the pregnancies resulted in living, normal babies. The number of miscarriages and abortions was only one fifth the rate among women achieving pregnancy without the aid of artificial insemination. More than 1000 mothers had more than one baby with the aid of this method.

More than 400 surgical operations of the type frequently performed on mothers to cure sterility and enable them to have babies were prevented.—*Science Service.*

FATIGUE

Timing Breaks Down When Skilled Workers Tire

TIMING is the first thing to go wrong when workers at highly skilled tasks get tired, Prof. F. C. Bartlett, noted British psychologist, states in the British scientific journal, *Nature.*

"Until a state of great fatigue is reached," he says, "it is far more likely that the right actions will be performed at the wrong times than that the wrong actions will be performed. If accurate timing is insisted upon, gross mistakes of action may appear."

The worker at such highly skilled tasks is, unfortunately, unaware when his work deteriorates with fatigue. He is likely to think he is doing better work, Prof. Bartlett found, because he becomes more and more lenient in his judgment of what errors are significant. When he does recognize an error, the fatigued workman is likely to blame it on conditions or on the interference of other people.

The fatigue that comes from highly skilled work makes the worker "forget" details not closely organized with the main part of his work. Yet, at the same time, he is more easily distracted by things that have nothing directly to do with the task. Bodily sensations, such as hunger or thirst, become more pressing and insistent, and affect worker performance, even in such easy tasks as the naming of colors.

Our Search for the Supernatural—VI

With the Aid of "Psychic" Powers a Table is Tilted, a Pendulum Clock is Stopped

A. D. RATHBONE, IV

Secretary, Scientific American Committee for the Investigation of Psychic Phenomena

● Scientific American, in collaboration with The Universal Council for Psychic Research, offers $15,000 to any medium who can produce a spiritistic effect or a supernatural manifestation under the rules and regulations published on page 210 of our April 1941 issue. ●

CONTINUING our search for the supernatural, Chairman Dunninger, of the Scientific American Committee for the Investigation of Psychic Phenomena, introduced Signor Raduano to members of the Committee, representatives of the press, and guests who had assembled July 21st in the Commodore Hotel, New York City. Through the aid of certain mysterious powers claimed by Signor Raduano, and which he prefers to term "psychic" rather than "supernatural," Dunninger explained that the signor would endeavor to stop a clock at a pre-designated time, and that he would attempt table levitation. Finally, stated our Committee Chairman, Signor Raduano would essay an unique and difficult experiment in telepathic-hypnotic clairvoyance. The latter, Dunninger added, does not fall within the realm of our Committee's investigation (Scientific American, April 1941), but in view of the popular interest evidenced by readers in telepathic, hypnotic, and clairvoyant ventures, and in deference to the signor's close study of these matters and his sincere application of his powers, it had been determined to try the experiment as an extra-curricular episode.

The clock in question was the property of Signor Raduano and resembled a type of pendulum time-piece often found in American homes of a generation ago. During introductory remarks it had hung on the black-draped wall of the room, facing the audience, but at this point it was removed and carefully examined by members of the Committee and press, none of whom could find anything untoward in the mechanism. So far as could be determined it was a normal time-piece in good working order. The clock was replaced on the wall, set for the correct time, and the pendulum was started in motion.

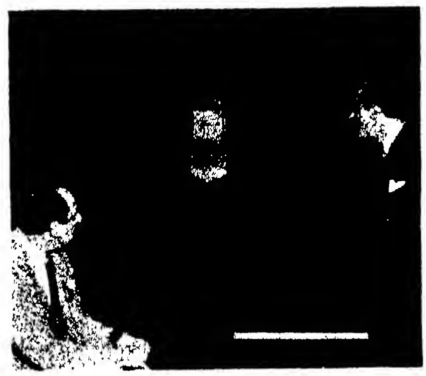
At Dunninger's request, the newspaper men present agreed on a moment at which Signor Raduano should endeavor to still the motion of the constantly swinging pendulum; the selection was announced as 4½ minutes to nine.

IT WAS then 10 minutes to that hour. Signor Raduano, a slight, dark man with unusually piercing black eyes that seemed to reflect unplumbed depths of mystic capabilities, folded his arms, cradled each elbow in the palm of one of his long-fingered hands and, standing sidewise to the audience, began gazing intently at the clock. Our Chairman, seated at Signor Raduano's right, likewise watched the time-piece with pronounced fascination.

Signor Raduano presents his pendulum clock to Dunninger and others for thorough inspection

A minute passed; two minutes, and the third and fourth fingers on the signor's left hand straightened out, then folded back about his right elbow. Next, the first and second fingers moved to a horizontal position where they remained stiffly stationary for long seconds, mechanically ticked off in otherwise utter silence by the pendulum. Again the fingers of Signor Raduano's left hand closed over his right elbow; again they moved, apparently by some sub-conscious reflex, and all the while his obsidian eyes never wavered from their intense stare at the face of the clock.

As the minute hand drew closer and closer to the appointed time, it seemed that the tenseness of the audience and of the signor became almost a tangible thing. "He has about a minute to go," remarked Dunninger in a guarded voice, and with that Signor Raduano put his right hand to his face, stroked his aquiline nose and his chin. His face muscles began to twitch slightly, his hand went back to his



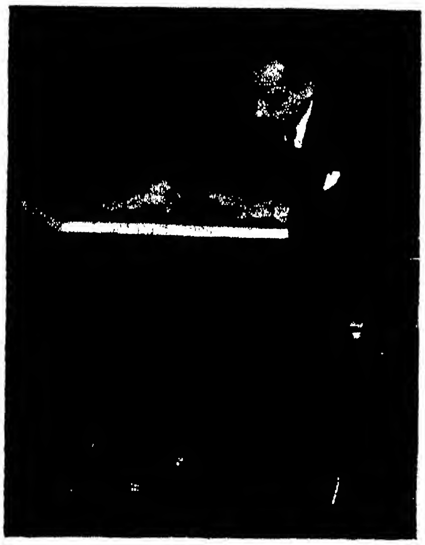
First effort through "psychic" power to make time stand still

elbow where it convulsively clutched the sleeve of his coat, and it was evident that the signor's concentration of mental or psychic power was reaching its zenith. "Just about time," whispered Dunninger, whereupon the signor turned his back to the audience, stretched out his left hand, fingers open, toward the obstinate, still moving clock. He opened the door of the time-piece, gestured energetically, but the inexorable pendulum continued unabated — and the time was then two minutes to nine.

As it was patent the first attempt had failed, Dunninger said kindly: "It's a

little late now, Signor Raduano. Would you like to try to levitate the table and return to the clock later?"

The signor at first used his own table, a light-weight, three-legged affair with a top approximately two feet square. He sat facing the audience with two of the tripod-like legs toward the group and the third toward himself. His own legs were sufficiently widespread that



Hands lightly laid on the top, the Signor prepares to tilt table

they did not touch the table legs and his only physical contact with the instrument appeared to be the flat of his two hands as he laid them lightly on the front edge of the table.

In the ensuing moment of concentration by both audience and demonstrator, the obstinate clock melodiously struck nine. Immediately thereafter a slight forward tilt of the table was observed, but it lasted only a few seconds and settled back almost at once. Then, with hands barely off the table, the back leg again left the floor for a brief interval. Once more the nervous agitation of the audience became a near-tangible force as people leaned forward in their chairs or stood upon them in order better to observe operations.

Signor Raduano removed his coat. He beckoned to a reporter who took his place at the table and allowed the signor to guide his hands to the outer, forward corners, where they lightly touched the top surface. The signor then placed his own palms between those of the newsman and drew them ever so lightly and slowly across the table top. After a few repetitions of this process, one leg was again discerned to be raised from the

Telepathic-hypnotic experiment by Raduano, Dagan, Dunninger

floor. Signor Raduano at once removed his own hands and for a few seconds the table remained in suspension, apparently motivated only by the palms of the reporter's hands. This performance was climaxed with the use of a small table, the property of the hotel, which was also tilted on two legs by the signor and so maintained without apparent physical contact with any part of Signor Raduano's body, other than his hands.

Noticeably weary from his intense mental and physical concentration, Signor Raduano nevertheless consented to again endeavor to stop the clock. It was then 9:17 P.M. and the newspaper men's group suggested 9:24 P.M. as a stopping time. In this instance the signor stood on the other side of the clock, but in the same arm-folded attitude. Once more his elbows were cradled within the palms of his hands; once more the fingers twitched convulsively. With greater intensity than ever, members of the audience leaned forward expectantly in their seats, for it was evident that the dark-eyed Signor Raduano had captured the sympathy of the group.

On swung the pendulum; the minute hand moved excruciatingly slowly, but it did move on toward the fateful moment of 9:24 P.M. At exactly 23 minutes past nine Signor Raduano's right hand shot forward in a determined gesture toward the face of the clock. It was as if this little man with the black hair and piercing eyes was telling all time to stand still. His forefinger pointed; then the second finger joined the first. There were 30 seconds to go; then 15; then 10, and finally only five. Suddenly the swinging pendulum showed its first sign of hesitancy. It wavered in its stroke; it slowed down; it stopped completely. The time was exactly 9:24 P.M., and Signor Raduano gleamed a brief smile of triumph.

THROUGH fortuitous circumstances it was possible for our Committee to place at the disposal of Signor Raduano a clairvoyant subject in the person of Roger Dagan. For the past 17 years Mr. Dagan claims to have practiced self-hypnosis and states he is able to mentally transport himself by this means to the world as it was a hundred centuries or more ago. Although the signor had been able to test Mr. Dagan's receptivity but once prior to the Commodore Hotel demonstration, both men agreed to attempt the experiment again in the presence of our Committee and their guests. Accordingly, Roger Dagan was seated in a chair at the front of the room. Signor Raduano pressed Mr. Dagan's head backwards and, in a voice inaudible to the witnesses, began talking to him and stroking his forehead, his eyes, the sides of his nose. In a few moments it was evident that the subject was completely relaxed.

"Headlines!" murmured Signor Raduano, "Headlines! Tomorrow's headlines—see the headlines!" he commanded. "Read what you see in the headlines! Speak!"

Meanwhile, Dunninger, pad and pencil in hand, had taken a stand just behind the subject's head. A moment of silence and then—"U. S. Needs Huge Army," came in a low monotone from Roger Dagan's lips. This was followed by, "Japs Accuse Soviet Russia," and with that Signor Raduano sharply slapped his subject's cheeks, shook his shoulders, spoke commandingly to him.

Mr. Dagan blinked a few times, shook his head, and rose to his feet, apparently none the worse for the experiment. What he had enunciated in his trance were purportedly newspaper headlines of the following day. Close study of New York City's dailies failed to show satisfactory evidence of success.

In conclusion of this month's story it must be remembered that Signor Raduano was given absolute freedom to perform whatever exploits he deemed pertinent and that he was in no way put to any test. The signor claims to have the ability to conduct other psychic experiments and it is anticipated that in the near future our Committee will recall Signor Raduano for further and still more interesting developments.

Across Panama By Road

Concrete Surface and Bridges Sufficiently Strong to Carry Safely a 55-Ton Tank

NOT SINCE the days of the gold trail of the 17th Century has there been a passable road across the Isthmus of Panama. Now, however, under blazing tropical sun by day and under electric lights at night, 1000 men are toiling on the construction of a highway that will cross the Isthmus, linking the Atlantic with the Pacific. Aided by giant scrapers and power shovels, by next spring these men will have completed a modern highway 24½ miles through hills and jungle from a point near the Fort Randolph Road in the Canal Zone to Madden Dam. Built for safe use at speeds of 60 miles per hour, the highway and its bridges will safely carry a 55-ton tank.

This section of highway is a part of the 50-mile Trans-Isthmian Highway which will connect Colon, on the Atlantic end of the Panama Canal with Panama City, on the Pacific end. Most of the highway that it was practical to locate within the Canal Zone has already been built. Now the United States is constructing the remaining 24½ miles, most of which is located within the Republic of Panama. All of the highway is on the South American side of the Canal. The accompanying map shows the location of the entire Trans-Isthmian Highway with respect to the Panama Canal, the railroad, and the principal cities in the Canal Zone and in Panama.

This road has been increasingly in demand since the opening of the Panama Canal in 1914. Under an agreement with the Republic of Panama, the Public Roads Administration of the Federal Works Agency, a U. S. Government unit, is in charge of the construction now in progress.

Not only will the new road provide for vehicular traffic across the Isthmus; it will also connect at the City of Panama with the proposed Pan-American Highway from the United States to South America. Between Texas and the Canal, this highway now consists of about 727 miles of cart and foot trails, and 2525 miles of roads that are either paved, all-weather, or dry weather. The last 164 miles to the Canal are paved. Except for about 25 miles of all-weather road below the city of Panama, the proposed location of the Pan-American Highway to Colombia is still impassable jungle.

Present plans for building the Trans-Isthmian Highway are the result of a treaty with Panama proclaimed in 1939. Under the terms of this treaty, the United States agreed to provide a corridor from the Panamanian city of Colon, formerly entirely surrounded by the Canal Zone, to the boundary of the Zone, and to construct a highway through this corridor.

The Republic of Panama, in return, agreed to provide a right-of-way to Alhajuela where the dam forming Madden Lake bridges the Chagres River and connects with the road from Alhajuela to Summit and the Pacific end of the Canal.

The road will have two 10-foot lanes of reinforced concrete, of nine-inch uniform thickness, separated by a four-foot bituminous strip. Eight-foot shoulders will be built on each side, making a roadway width of 40 feet. The minimum radius of curvature is 573 feet, and the minimum sight distance is 600 feet. The maximum plus grade toward the Pacific will be 5 percent. But toward the Atlantic the maximum plus grade will be 7 percent for grades not more than 400 feet long, and 6 percent for longer grades. The total excavation on the road is estimated to be a little more than 3,000,000 cubic yards.

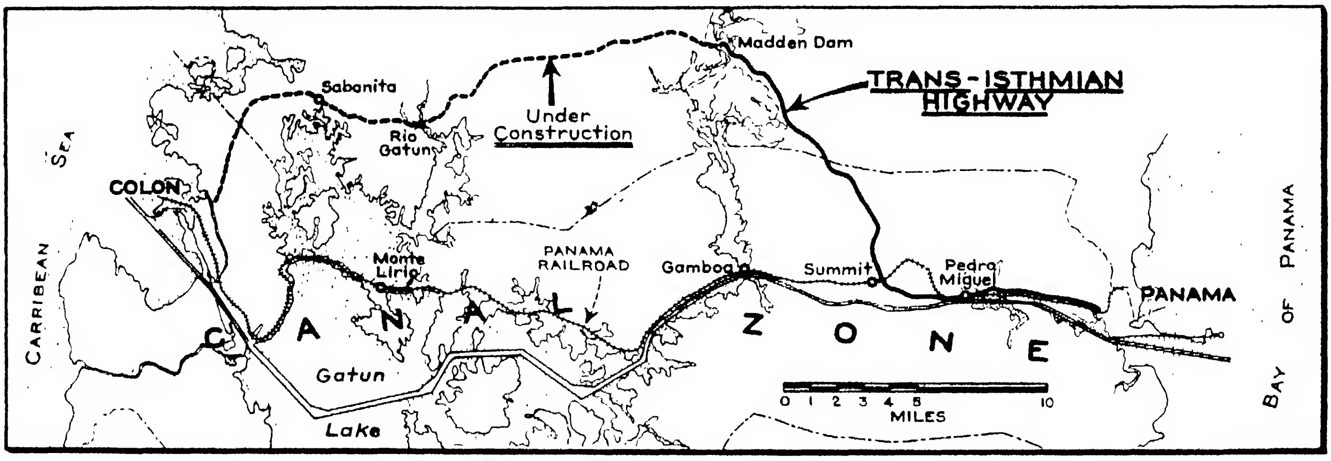
Most of the excavation is expected to be of the "common" classification, although considerable ledge rock has been uncovered on the Madden Dam end, and more is expected in the deeper cuts. Some of the heavier cuts and fills approximate 100 feet in depth.

EXHAUSTIVE soil tests are being made by Public Roads Administration soils engineers assigned to the work. Their tests will reveal the composition and classification of materials, the maximum permissible heights of fills and the safe angle of slope for cuts and fills.

More drainage structures are required on this route than are needed on most roads of equal length in the United States, because of the heavier rainfall. The average annual rainfall in Panama is about 100 inches, most of which falls from May to December, the rainy season.

Six major bridges, six minor

Culvert construction where grade line is 97 feet above the culvert. Aggregates slide down to mixer; concrete is poured, by another chute, to culvert



Route of the Trans-Isthmian Highway that will connect the Atlantic and Pacific ends of the Canal

bridges, and numerous culverts are required. The largest bridge, that over the Rio Gatun, will be 330 feet long. Each of the major structures will have three spans, with continuous steel girders. The decks will be of reinforced concrete, with a roadway width of 26 feet between curbs. Railings will be of structural steel.

In designing the bridges it was desired to avoid any sort of portal structure and to select a type of structure that could be erected regardless of weather conditions. These requirements were met by a deck structure that could be erected without falsework.

THE location survey was started from three points in October, 1940, and was completed last April. Construction of concrete box culverts is being carried on directly in advance of excavation work, and clearing and grubbing work is proceeding from various points on the projected line.

At the time of writing, grading operations are in progress out from Madden Dam, from Rio Lopez southeastward to Rio Gatun, and in both directions from Rio Gatun near the site of the bridge crossing.

At the present time nearly a thousand men are employed on the engineering and construction of the highway. They are housed in camps located at Sabanita, Rio Gatun, and Madden Dam. Electric lights have been installed so that some of the work is on a 24-hour basis, six days a week. Twenty-seven 12-yard tractor-scraper units, three 1½-yard power shovels, and two ¾-yard draglines are in use. In addition to the tractor-scraper units, 15 bulldozers are used for pioneer road construction and opening large cuts. A portion of the excavation is of such a nature that movement of earth by bulldozers is very economical.

All clearing and grubbing is done by native machete men; four treedozers assist in removing from the right-of-way large trees that have been felled by the machete men.

Two eight-inch sand and gravel pumps mounted on barges are at work in Rio Gatun approximately one mile from where the route crosses the river. Sand and gravel are pumped 600 feet to a plant where they are loaded into six-yard trucks which haul the aggregates over a pioneer road to the batching plant at the crossing of the Rio Gatun.

Most of the heavy duty equipment—shovels, tractors, and scrapers—was unloaded at Monte Lirio on the Panama Railroad and carried by barge 11 miles to the point where the highway crosses the Rio Gatun. At other points where camps were established, pioneer roads were constructed and equipment, supplies, and materials were sledded in, using tractors.

Panamanians are employed extensively for the unskilled labor in clearing and grubbing and other construction operations. Panamanian instrument men, chainmen, rodmen, and machete men are employed with the engineering parties. Operators for the heavy power equipment have been brought from the United States because of the need for men skilled in the use of these types of equipment. Panamanian laborers are given every opportunity for employment in all positions for which they may be qualified.

Cement will be shipped in a chartered bottom in order to assure a constant supply. It will be brought to the work through Summit and Monte Liro by truck and barge, respectively. Cement and structural and reinforcing steel will be shipped from the United States. Construction of reinforced concrete pavement will begin in the near future.

All engineering and construction work is being carried on by the Public Roads Administration under an agreement with Panama. Panama furnishes all right-of-way and deposits of local materials.

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SAFE AT WORK

Record of Employees In Petroleum Industry

OIL-COMPANY employees in 1940 sustained only a little more than half as many fatal injuries while on duty as they did when not working, a review of the fatalities by the American Petroleum Institute's Department of Accident Prevention reveals.

The 1940 fatal-injury record of the petroleum industry was the lowest since data have been reported, according to H. N. Blakeslee, director of the department, and was 49 percent below the fatality rate in 1930.

Oil companies employing 327,112 workers reported 101 fatalities last year, or a rate of 30.9 per 100,000 workers. Off-duty fatalities of oil-company workers, reported for more than two-thirds of these employees, were almost twice as high as the industrial fatalities. The rate per 100,000 employees for those reporting both industrial and off-duty fatalities was 28.3 while on duty, compared with 48.3 while off duty.

Plain Water's Unplainness

Recent Research Reveals Some Odd New Facts About Common, Ordinary "Simple" Water

WALTER L. FINLAY
Remington Arms Company, Bridgeport, Connecticut

"EUSTACE, here," the Research Director crowed fondly, "has just discovered a cheap substitute for water!" Thus quipped a recent cartoon. But before his Board of Directors could be lamentably sure that they had the biggest white elephant of all time on their hands, Eustace would have a lot of work ahead of him until he established that the new "Eustacium" duplicated water in all important respects. For water —common garden-variety water— is not so simple a substance as first it seems.

Quite early the schoolboy learns that water is H_2O; that it freezes at 32 degrees, Fahrenheit, and boils at 212 degrees, Fahrenheit. Later, about the time he substitutes 0 degrees, centigrade, and 100 degrees, centigrade, for the more plebeian Fahrenheit points, he adds the qualification "under a pressure of one atmosphere." Then the complications begin. It seems that all water is not just H_2O; it seems that there is a variety termed "heavy water"; it seems that not merely one but seven different ices exist; that pure water is actually stronger than pure lead or pure tin; that, even when at the boiling point, water always contains a high percentage of ice; that pure water does not freeze at 32 degrees, Fahrenheit (or at 0 degrees, centigrade, either); that water at atmospheric pressure can be heated past its traditional boiling point of 212 degrees, Fahrenheit, without boiling; conversely, that water can readily be cooled 10, 20, even 30 degrees below the time-honored 32 degrees, Fahrenheit, without freezing; and finally it seems that 700-odd closely printed pages in a recently-published treatise by N. Ernest Dorsey, were barely adequate to describe the "Properties of Ordinary Water Substance." The glass of water tossed off unheedingly several times a day is thus seen to be a rather remarkable fluid.

Assuming that this glass holds the usual eight ounces, the drinker swallowed about 780,000 billion billion (780,000,000,000,000,000,000,000) H_2O molecules seasoned with some 120 billion billion D_2O molecules. The latter — dubbed "heavy water" or deuterium oxide —differ from the usual water molecules in that their hydrogen atoms possess twice the mass of the standard hydrogen. One hundred and twenty billion billion D_2O might appear to be quite a mouthful of molecules but heavy water constitutes less than 1/50 of 1 percent of all the water molecules present in normal water. As a matter of fact there are almost as many dissolved air molecules present in water under room conditions as there are heavy water molecules. A census of the eight-ounce glass would roster about 45 billion billion oxygen and some 50 billion billion nitrogen molecules. The latter figure includes the numerically insignificant rare gases —argon, neon, helium, krypton, and so on. The 45-to-50 oxygen-to-nitrogen ratio reflects the fact that water prefers oxygen to nitrogen. Fish, therefore, enjoy a more stimulating oxygen - to - nitrogen ratio than man, but their's is much more dilute.

Figure 1: **Tyndall's ice flowers**

Dissolved air is no exception to the rule that dissolved impurities raise the boiling point and lower the freezing point of water. Since the freezing point of water is normally determined in the presence of air—and the 32 degrees, Fahrenheit, and 0 degrees, centigrade, thermometer points are so fixed— the freezing point of pure, air-free water is higher than 0 degrees, centigrade. The exact figure is 0.0024 degrees, centigrade.

Dissolved air also acts as a sensitive set of nuclei about which bubbles can form. Hence, while air-free water can frequently be raised considerably above the boiling point before boiling begins, provided the liquid is not subjected to shock of any kind, it is extremely difficult to heat aerated water beyond 212 degrees, Fahrenheit, without boiling. The world's record for this is an almost incredible 270 degrees, centigrade, obtained in 1924 by the research team of Henrick, Gilbert, and Wismer. They used a capillary tube under normal atmospheric pressure. When boiling does start in such superheated water the entire mass flashes into steam with explosive violence. The tendency of dissolved air molecules to act as points about which additional air or water vapor molecules can congregate as bubbles also lowers the tensile strength of the water.

BUT IN what sense does a liquid have a tensile strength? Recalling that tensile strength is normally determined by pulling a rod or other suitable solid shape into two pieces, it would seem to require a neat trick to pull a column of water apart. Marcellin Berthelot, the first great organic synthesizer, did just that, however, and he did it quite simply. Berthelot enclosed the liquid in a sealed tube which it almost completely occupied. Careful heating then expanded the liquid until it just completely filled the tube. Equally careful cooling tended to contract the liquid; but, for a time, dog-in-the-manger-like, it clung to all the volume it had gained. As the force of contraction increased, Berthelot literally stretched the liquid until, with a distinctly audible snap, it gave way. From the difference in the volumes he thereupon readily calculated the force required to tear liquid water apart. The highest value so far recorded is 2400 pounds per square inch; which, Mr. Ripley might be interested to know, considerably tops the ten-

sile strengths of lead and tin.

When water is protected from the air, as by sealing it in a Berthelot bulb, it can often be easily cooled below 0 degrees, centigrade, without freezing. Temperatures down to —21 degrees, centigrade, have thereby been repeatedly attained without freezing. One unconfirmed report gave a record low of —40 degrees, centigrade. Nature, not to be outdone, has provided her own "Berthelot bulbs" in the form of tiny natural cavities in quartz filled with very nearly pure water. And as far back as 1858 John Tyndall, of "Tyndall phenomenon" fame, found that he could supercool these liquid inclusions to —20 degrees, centigrade, without freezing the liquid. Still more interesting than these quartz cavities are the same investigator's "ice flowers." Tyndall observed that, when a beam of light was passed through a block of ordinary ice, its path rapidly became marked with bubbles from which grew six petals, as illustrated in Figure 1. A clicking accompanied their growth, since the water that was formed occupied less volume than the ice which gave it birth and, just as in a Berthelot bulb, the liquid water was stressed by continued melting until it snapped audibly. Ice flowers are a strange phenomenon, and not a least part of their strangeness is the fact that they are invariably formed by the internal melting of the ice. That is, the heat from the Sun first traverses the upper part of the ice without melting it and then neatly carves out, by melting just the right portions of ice somewhere in the middle of the block, a six-petaled and often perfectly-proportioned flower.

Many of water's unique properties arise from the fact that the water molecule is electrically positive at one end, where the two positive hydrogens cluster, and electrically negative at the other end where the negative oxygen dominates. Figure 2 illustrates the structure of the water molecule. Neither hydrogen molecules (H_2) nor oxygen molecules (O_2) have positive and negative poles. But when they react to form water the bigger oxygen atom shares two negative electrons with each hydrogen atom, the way Hitler shares "living room" with his neighbors. As a result, the oxygen becomes negative, leaving the hydrogen atoms in a positive state.

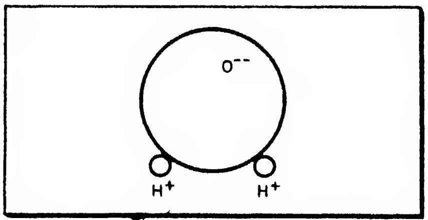

Figure 2: **Structural model of a molecule of water, showing the origin of its dipole moment**

Since unlikes attract, the positive end of one water molecule tends to attach itself to the negative end of another. The force tending to prevent this association is heat—the hotter a substance becomes the more lively do its molecules dance and the more vigorously do they bounce their neighbors away. Thus, when water boils, the molecules jig so agitatedly that vapor rather than liquid or solid is the normal state. Flying about thus fancy free, the water molecule is solitary, that is, $(H_2O)_1$. But when enough heat is removed, the molecules bounce each other about less energetically and the H_2O's pair off. In fact, many do not stop at pairing but form threesomes. Thus liquid water, from its freezing point right on up to its boiling point, is a mixture of $(H_2O)_3$ and $(H_2O)_2$. The startling aspect of the foregoing is that ice—ordinary frozen water—has been demonstrated to be $(H_2O)_3$: thus all plain liquid water is a solution of ice in a liquid of simpler molecules.* The evidence for this $(H_2O)_1$-$(H_2O)_2$-$(H_2O)_3$ picture has been accumulated during the past 40 years and is too involved for discussion here. A very crude analogy, however, is furnished by a brick wall. If pulverized brick dust floating about in the air is taken to represent water vapor, $(H_2O)_1$, then $(H_2O)_3$ would be represented by a brick. A haphazard jumble of bricks and partially agglomerated brick dust would thereupon symbolize liquid water, whereas ice would be a regular arrangement of the bricks as in a wall. Several different regular arrangements of bricks are possible and, as intimated in the opening paragraphs, no fewer than seven different ices, or arrangements of $(H_2O)_3$ molecules, are known. Very few persons, however, have ever seen or handled any ice other than Ice-I. Figure 3 shows why. It indicates under just what conditions of pressure and temperature the various forms of water can exist—and Ice-I is the only ice existing under normal atmospheric temperature and pressure. The dotted line in Figure 3 indicates the pressure-temperature conditions under which man lives; that is, one atmosphere pressure (roughly 15 pounds per square inch at sea level) between —30 degrees, centigrade, and 50 degrees, centigrade.

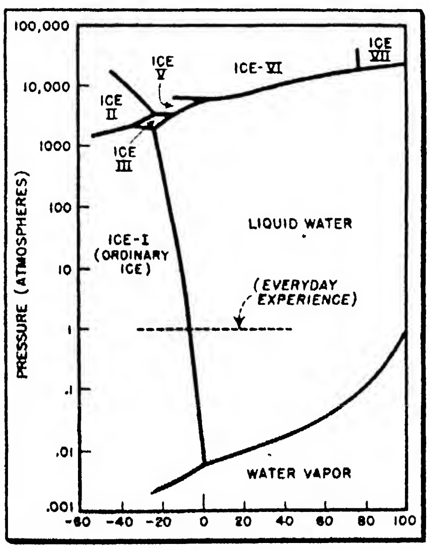

Figure 3: **Phase diagram, water**

Viewed on such a broad general scale as Figure 3, the human range of temperature-pressure experience seems circumscribed indeed. The solid lines in Figure 3 separate regions within which the form of water labelled is stable. By stable is meant the form into which all other forms, transported to its region by an appropriate pressure-temperature change, will transform. Thus, at the center of the dotted line, liquid water is stable; moving to the left by lowering the temperature transports the liquid to the Ice-I region, whereupon it freezes into Ice-I; moving to the right by raising the temperature transports the liquid past the end of the dotted line and eventually to 100 degrees, centigrade, whereupon it boils and becomes vapor.

The secret of Sonja Henie's effortless skimming is also contained in Figure 3. It lies in the slope of a line, the line separating Ice-I and Liquid Water. If that line were sloped to the upper right Miss Henie's flying feet would be grounded; her skates would stick

*The alert reader might wonder, if the $(H_2O)_2$ were separated by some means from a sample of hot water, whether only ice would remain. The answer is no. If $(H_2O)_2$ could be removed from liquid water, enough of the $(H_2O)_3$ would break down into $(H_2O)_2$ to maintain the original ratio of $(H_2O)_2$ to $(H_2O)_3$.

to the ice. But ice melts under pressure. To represent this fact the line slopes to the upper left, indicating that the localized pressure of the edge of the skate runner melts the ice and the skater skims along on a film of liquid water. However, when the temperature gets far enough below freezing, this pressure is no longer

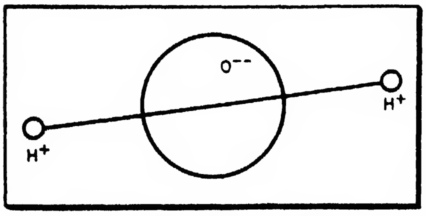

Figure 4: **Impossible structure of an H_2O molecule, without poles**

sufficient to melt the ice and the skater, her runners sticking, is reduced to walking.

Still more interesting than its explanation of ice skating is Figure 3's representation of the pressure-temperature relations under which six separate and distinct forms of ice can exist. Perhaps the most spectacular of these is Ice-VII—hot ice which, before it will freeze—that is, change from the liquid to the solid state—requires that the water be heated to at least a scalding 179 degrees, Fahrenheit! As the phase diagram shows, if the water is at any lower temperature than this, the formation of Ice-III, V, or VI, instead of Ice-VII, will occur with the application of sufficient pressure. And if enough pressure is applied, Ice-VII can even be frozen from water which is well over the normal boiling point, 100 degrees, centigrade.

None of these forms of ice can exist under pressures of much less than 2000 atmospheres. However, Tammann has been able to remove both Ice-II and Ice-III from the pressure chamber and examine them under atmospheric pressure during the short period before they transformed to Ice-I. Both slowly swelled and broke up into a coarse white powder consisting of ordinary ice. The seventh form of ice, Ice-IV, is unstable and occasionally forms in the region of Ice-V.

Figure 4 is based on the water molecule of Figure 2. If a pulp-magazine bad man were somehow to manage the minute shift of less than 0.000,000,01 of an inch in the position of the hydrogen atoms in the water molecule, as shown in Figure 4, most forms of life would speedily cease to exist. Figure 4, unlike Figure 2, illustrates a molecule without positive and negative poles. And life as we know it is unthinkable without water having the properties bestowed by the polarity of the water molecule. For the polarity—the positive and negative poles—of the latter gives to water the tendency of the molecules to associate in pairs and threesomes; the remarkable dissolving powers which have earned it the title of "universal solvent"; and the abnormally high physical properties such as surface tension and boiling point which render it invaluable. Should the shift to the Figure 4 structure transpire, the change in surface tension alone would fatally upset the delicate balance of many bodily functions; moreover, the lowered boiling point and lowered heat of vaporization would prove but poor defense against the Sun's heat and what life might survive for a short period would find much or all of the Earth's water evaporated.

Fortunately, however, there is no likelihood that any misanthropist will ever be able to effect this shift. Moreover, there is little point in speculating on the characteristics of a hypothetical water molecule when, despite the already vast accumulation of data on the properties and vagaries of ordinary water substance, a large and fertile field still is unexplored. And, as sure as plain water is not plain, additional proof of its unplainess will reward the diligent investigator who draws the subject of his study from the lowly tap.

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ATOM SORTER

For High-Speed Analysis in Many Processes

PRESENT indications point toward use of a new portable mass spectrometer (see page 118) as an accurate tool for high-speed analysis of gas in oil refining and prospecting, and in heat-treating and hardening of steel. Other uses involve tracing of carbon and other elements in animal bodies in an effort to learn more about vital processes.

The new analyzing machine, demonstrated recently at the Westinghouse Research Laboratories by Dr. E. U. Condon, associate director, and Dr. J. A. Hipple, research physicist who developed the device, can sort out by weight the molecules and atoms which are the building blocks of all matter. It can quickly answer questions about intricate combinations of gases which are very difficult or impossible by ordinary chemical methods. With a little further development by oil company laboratories, the "atom sorter" probably could improve the quality of refinery products by keeping a constant check on the separation and combination of gases, and there are possibilities that the instrument can assist materially in the discovery of new oil deposits by analyzing soil gases.

"Until about 25 years ago," said Dr. Hipple, in explaining the operation and use of the "atom sorter," "it was believed that all atoms and molecules of a chemical element, such as hydrogen, oxygen, or iron, had the same weight. But recent research has shown that almost all elements contain a mixture of atoms falling into two or more weight groups. These weight groups are called isotopes, some of which are abundant, others very scarce. The portable mass spectrometer can detect and measure the percent of atoms in each of these weight classes, even when they are as scarce as one part in 100,000.

"Since the difference in weight has almost no effect on the way the particles of an element behave in chemical reactions, it gives us a valuable method of atomic analysis. For example, when a lot of heavy carbon atoms are fed to a guinea pig, these atoms go through the digestive processes just the same as other carbon atoms in the animal's diet. Then the biologist can discover where all the carbon goes in the guinea pig by analyzing bits of his body in the mass spectrometer until he discovers places where the heavy carbon atoms show up in abundance. Such research often reveals valuable clues about the bodily processes."

The portable mass spectrometer sorts atoms and molecules by shooting them around a bend in a glass vacuum tube at speeds up to a million miles an hour. The curved part of the tube is encased in a powerful electromagnet which bends the paths of the atom. The lighter the atom or molecule, the more its path is bent. At the other end of the tube the percentages of particles of different kinds are measured with electric meters.

A False Paradise for Pests

Intensive Investigation of Control Methods for Man's Multitudinous Living Enemies

CHARLES M. HACKETT

"A GROWING plant," observed the hard-bitten farmer, "hasn't got a friend in the world."

He regarded the green corn nodding at knee-level and lamented the ancient hazards of husbandry.

"That seed I put in the ground—like as not there was disease on the kernel itself. There was more in the soil. If the plant survived and grew, there were bugs waiting for it. If the bugs didn't get it, the wilts, smut, galls, or root rots might. If it gets through and grows corn, there's still more bugs waiting for it in the warehouse.

"I declare," he concluded morosely, "I don't see how so much stuff grows as does!"

The farmer's discourse, while non-scientific, is close to the truth. And scientific men know, only too well, the importance of keeping these enemies of the growing plant under control. For convenience sake, they class them all under a single head—pests. This terse designation is now a vital word in modern agricultural economics—and in public health statistics as well.

Pest control is a well-established science, supported by millions of dollars in Federal and State funds and the expenditures of endowed institutions and private manufacturers. The defense budget is large, but its significance may be judged by the estimate that "pests"—including insects, weeds, and the fungi that cause plant diseases—cost the nation more than $6,000,000,000 a year.

This spring, a new laboratory devoted to pest-control research was completed at Wilmington, Delaware, as a part of the Experimental Station facilities of the Du Pont Company. It replaced a smaller structure where, since 1937, scientists have been coping with the problems of insects, damaging fungus growths, and other challengers of man's preëminence. The new laboratory is believed to provide the most modern equipment in the world for the study of insecticides and fungicides.

All photographs courtesy Du Pont Company

Field conditions are closely paralleled in the laboratory. Carbon arc lamp simulates sunlight

"Pests," says Dr. Wendell H. Tisdale, director of the laboratory, "can be defined as those living things that cause discomfort, annoyance, or disease of humans, and those that compete with the human race for its means of subsistence. Scientifically, we group under pests destructive insects, protozoa, worms, marine forms (such as teredos, barnacles, squids), rodents, fungi, bacteria, weeds, marine algae, and other harmful forms of animal and vegetable life.

"Pests compete with man for his every means of life. They invade and infest everything. They attack from the air, soil, and water. Our animals, plants, foods, clothing, buildings, furniture, ships, and numerous other items are damaged or destroyed by them. Humans are tortured with bites, stings, diseases, and death, sometimes in its most horrible forms.

"Pests attack from all sides," continues Dr. Tisdale, "and advance in overwhelming numbers. A prominent entomologist has said that one would have to learn the names of 10,000 species of insects a year for 60 years to know them all. Bacteria and fungi or molds also can be enumerated in terms of thousands of species. Many insects, in addition to the direct damage they cause, spread other disease-producing pests such as protozoa, worms, bacteria, fungi, and viruses, which may be even more destructive to humans, animals, and plants than the carriers that spread them."

The new laboratory at Wilmington is equipped for the chemical and biological exploration necessary to develop and evaluate pest control chemicals. Insects of various kinds are raised and their habits studied for a clue that might show a chink in their armor. Elaborate equipment is employed, permitting experimenters to reduce greatly the time required to complete studies under less favorable circumstances. The peculiar habit of the Japanese beetle, for example, of gorging itself on bright, hot days when the humidity is high is indulged by favorable artificial weather conditions.

A coördinated program is carried out. Laboratory work is followed by field investigations of promising chemicals under a wide range of conditions. Thus it is possible to keep a proper balance between biological and chemical development. Thousands of new compounds have been prepared and tested within the past few years—more than 700 chemicals are examined at the laboratory yearly for their toxic qualities. The work is painstaking and often discouraging, but diligent inquiry

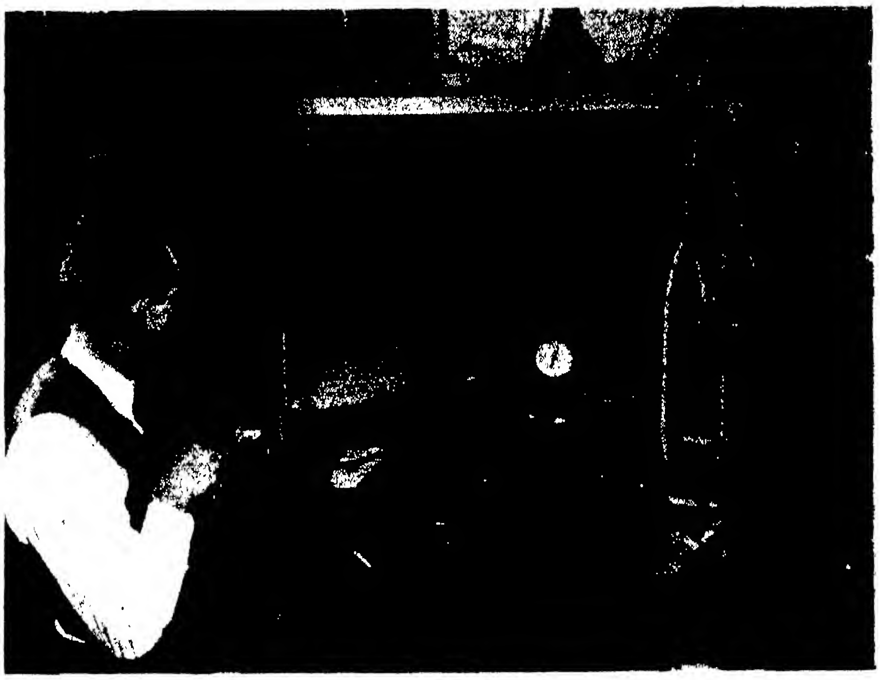
under controlled conditions is its essence. A single chemical has been subjected to as many as 286 modifications before being declared adequate for the assigned task.

Let's trace a typical experiment. A chemical is found which, after laboratory analysis and study, seems to show stomach insecticidal possibilities. It's makeup and behavior indicate possible effectiveness against the Mexican bean beetle. So a small quantity is prepared and passed on from the chemist to the entomologist for actual testing.

This scientist has a number of bean beetles in all stages of growth, reared in pampered captivity to die for science. From the greenhouse he selects pots of growing bean plants, favorite ration of this beetle. These plants are now sprayed with various concentrations of the new chemical, sequestrated in tagged jars, and hordes of hungry beetles are turned loose on the foliage.

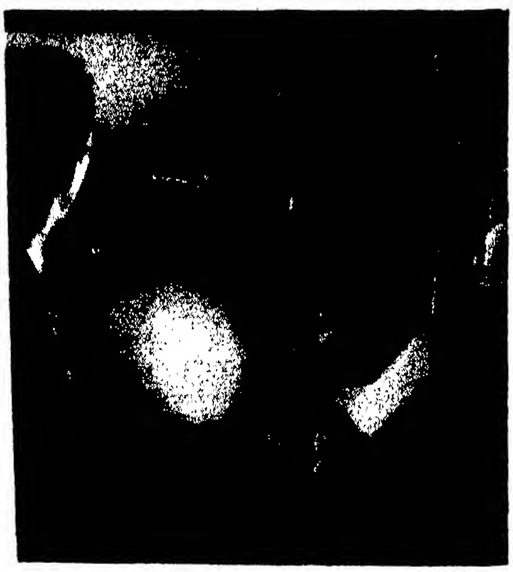
The job now becomes a matter of tabulation. The damage done to each plant is carefully noted. What percentage of the beetles were dead in each test as compared with controls? How did the new chemical compare with chemicals in common use for the purpose?

Assume that the new compound is shown to be an excellent repellent or stomach insecticide. The trail is only slightly warm; how will it stand up under sunlight, rain, sudden changes of temperature? Will it of itself harm plants or domestic animals? In the greenhouse, treated plants are subjected to the rays of a huge carbon-arc lamp, said to be the closest thing to natural sunlight ever devised. Another period of painstaking analysis ensues. Every other circumstance of usage is anticipated and properly tested in the greenhouse.



Laboratory apparatus duplicates effect of pressure sprayers used in field

Assume again that Chemical X passes all these tests with flying colors. Now, how will it mix with the various spreading and sticking agents which would be necessarily be incorporated in a commercial insecticide? More calculating and experiment, more patient testing, more tabulation, and then the analyses of results.

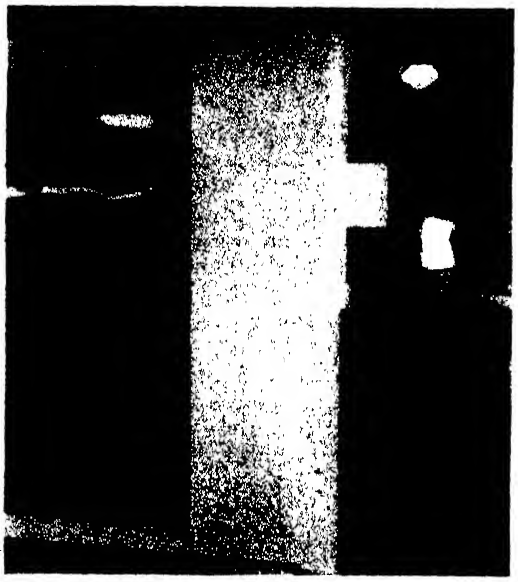


Apples are thoroughly coated with chemical spray in this laboratory setup. Codling moths are then hatched on the apples and spray value is checked

If the chemical survives these tests, it is tried out on the experimental test plot, where plants are grown under garden conditions. Should this performance still be satisfactory, the chemical is ready for more extensive field tests. Samples are shipped to all parts of the country and tried out under various climatic conditions. Reports arrive from the field and the results are weighed against each other and against laboratory conclusions. Certain changes in formula are suggested by the field observations and new trials are initiated. Only after such extensive search and checking of results is a pesticide recommended.

The outline presented here is, of course, highly simplified, but in its broader sense it is representative. The research plan is pacing the present trend away from the older "universal" pest poisons and toward specific chemicals for specific purposes. Achieving this end requires full study of the exact differences in living matter. It is recognized that thorough and expert scientific service is necessary. The problem at hand must be accurately diagnosed and the most effective remedy prescribed. Scientists at the laboratory predict that this method will become increasingly important with future developments.

THE GROWING economic importance of pest control has emphasized the necessity of measures consistent with the needs. Entomology for too long was regarded as a high-brow, purely academic subject. Its practitioners were once ridiculed as mysterious and slightly comic fellows, pursuing butterflies with nets. Happily this myth has been dissipated. There remains, however, a greater need for the realistic approach such as that taken by organizations like the one under discussion. In entomology, the gap between theory and practice is a hard one to span. Dr. Tisdale regards confirmation of laboratory findings by actual, extensive field tests as an essential.



Fly laboratory, with "lethal chamber" at left. *Below:* Inside the chamber are numerous buzzing flies. Insecticides are introduced by air gun, results tabulated

"Chemical warfare against pests is one of our most effective methods, if used properly," he says. "Chemicals can be used in many ways, including injections, baths, dips, lotions, sprays, dusts, poison baits, anti-fouling paints, explosives, and gases. Despite this array of applications there are many problems unsolved or only partially solved. The pests with which we have learned to live, but not trust, are many.

"IN THE earlier use of chemicals, the relatively few well-known inorganic poisons were employed. Some of them are still extensively used. The gradual increase in the numbers of pests and the resulting demand for more frequent and general use of chemicals has aroused anxiety over the possibility of poisoning humans who eat treated fruit or other treated food products, or who may come in contact with excessive amounts of poisonous pest-control chemicals. Cases of persons being poisoned by insecticides on fruits and vegetables are, however, extremely rare.

"Extensive investigations are directed toward improvement along many lines of chemical control. Better stomach and contact insecticides, insect repellents and attractants, rodent and other animal poisons and repellents, fungicides and bactericides, and more effective, safer weed killers are needed. Effective means of removing poisons from fruit and vegetables have been developed. Safety measures for handling poisons have been devised and further studies are under way.

"Still the need is for safer and more effective synthetic chemicals. They are hard to find, but the task does not seem impossible. Plant products such as rotenone and pyrethrum give us something at which to aim, but these imported natural plant products are unstable and the supply is uncertain. When synthetic products are found, the supply and uniformity can be regulated, as is shown by the recent chemical development of a synthetic insecticide base which reduces American dependency on imported pyrethrum."

The use of "parasites," or natural enemies, to destroy pests has been successful in some instances. In nature, many common and potential pests are held in check by other species which prey on them. A pest introduced into new territory, free of its natural foes, may develop at a rapid rate and cause enormous damage. A careful study of the pest in its native haunts usually reveals natural enemies often previously unknown. Many of such natural enemies are not adapted to different conditions, but generally some are.

Two wasp-like insects which prey on the Japanese beetle have been introduced into this country and are apparently becoming adapted. It is hoped these will eventually control the beetle, at least until a better means is devised. Fluted scale once threatened the citrus industry of California until a small lady beetle that feeds on the scale was introduced from Australia. It has kept things under control ever since. One of Australia's chief weed problems is a prickly-pear type cactus plant, which spreads rapidly, and once ruined thousands of acres of the best agricultural land. In the course of a scientific search for effective parasites, a bacterium was found that destroys the cactus. Following its release, this parasite was spread by cactus-feeding insects and is proving very effective.

There is, of course, the danger that the cure may prove as bad or worse than the pest. The West Indies, for instance, once imported the cobra-killing mongoose from India to fight rats. All went well until the rat population was annihilated, after which the embarrassed zoologists wondered how to get rid of the mongoose. Its appetite for native wild birds, chickens, and even cats made the rat seem relatively harmless. Since 1910, this animal has been denied entrance into this country.

"More should be done toward studying the natural enemies of pests," Dr. Tisdale agrees. "In the meantime, chemical research applied to pest-control problems appears to offer the best solution."

INVESTIGATIONS at the new laboratory cover a wide range in following out this approach. In addition to the usual problems of insect and fungus disease control, the work includes development of non-poisonous fungicides for use on stored agricultural products such as fruits and vegetables; wood preservation for the control of stains, fungus decay, and termites and other insects; preservation of cellulosic materials; preservation of harvested plant products; weed extermination; and a study of plant hormones.

"Progress appears to be slow despite the accomplishments," Dr. Tisdale admits. "Organized investigations directed toward more effective means of pest control have not been commensurate with the suffering and tremendous economic losses caused by the mul-

titude of destructive pests. However, there is a real awakening. The battle is between overwhelming numbers and dogged persistence on the part of pests against the intellectual methods of man. Which will win? I should prefer to gamble on the cunning of the human mind."

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FLYING SUITS

Wired for Comfort at All Temperatures

MANY pounds lighter than the sheepskin-lined garments which they replace are the new electrically heated flying suits now being manufactured for the United States Army Air Corps by the General Electric Company. This saving in weight alone is a definite advantage to aviators, giving them far more freedom for manipulating instruments, controls, and armaments. The suits are designed to keep the

Stratospherian dress

wearer comfortable through a 130-degree range of temperature from 70 degrees above zero to 60 degrees below.

The final design of these suits, reached after much experimental work, involves an outer shell of pure wool, cut on the bias for elasticity. Sewed to the inside of this shell are the resistance wires that supply controlled heat when current from the airplane's battery passes through them. Inside the wires is a lining made of 100 percent cotton cloth. The cotton lining permits passage of heat to the body, while the outer woolen shell reduces heat loss to the air.

Wired cloth boots made of overcoat material with molded rubber soles are provided to keep the aviator's feet warm. The electrified boots are worn inside standard light aviation boots. Wired into the circuit between the battery and the heating elements in suit and boots are suitable controls to adjust the heat delivered to the body to the correct amount to compensate for changes in external temperatures.

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MAN SLUMPED: The knights of the Middle Ages were mere pigmies compared to present military standards, for a twelve-year-old American boy of today can scarcely get into their suits of armor.

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LAWN IMPROVEMENT

Directions by Experts for Maintenance

IN SPITE of the fact that golf greens are seeded in the fall, rather than in the spring, and that most experienced professional gardeners follow the same practice, there are thousands of home owners who cling tenaciously to the erroneous idea that spring is the time to sow all seeds.

The real enemies of grass are, in order of their importance, extreme heat, drought, and weeds. None of these occurs during fall and winter and new grass withstands the rigors of cold weather with little injury. Soils in the early fall, too, are easy to work. J. W. Lentz, Director of the Scott Lawn Research, declares most emphatically that: "Fall weather is nearly ideal both for quick germination of grass seed and for the development of a deep, sturdy root system." The seeds lodge in the warm soil, are aided by favorable temperature variation and by adequate rains.

The mechanical consistency of the soil is a prime factor in building a new lawn. Clay, silt, sand, and gravel in about equal proportions makes an ideal foundation for the perfect lawn, and the area should slope one inch in every ten feet to insure good surface drainage. The addition of liberal quantities of humus such as peat, sludge, or well rotted manure vastly improves the mechanical condition of any soil. At the same time, it is good technique to apply a good special food for grass, working in both humus and fertilizer to a depth of from two to three inches. Where grubs are known to infest the soil, about 10 pounds of lead arsenate per 1000 square feet should be applied and thoroughly raked into the soil.

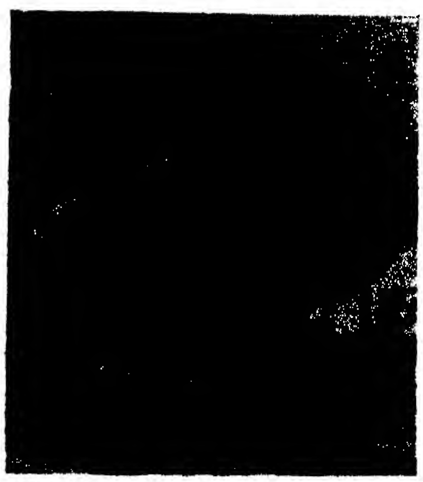
Early fall seeding is recommended by most turf authorities and it is best done in two directions to ensure an even coverage. The ground should then be given a light raking and rolling so that the seed is firmly implanted in the soil.

Established lawns, too, can best be renovated in the fall. If the lawn is in such poor condition that reconstruction is advisable, determine the cause of the present failure and guard against its recurrence. Of course, even a good lawn will benefit from seeding and feeding at this season; the lawn should be vigorously raked so that the seeds will lodge in the loosened soil surface. Irrespective of weather conditions, a good lawn mixture, according to a report from Scott Lawn Research, will not be harmed if it lies dormant in the soil for several weeks. If the new fall seeding is once watered, it should then be thoroughly sprinkled several times daily thereafter in preference to one heavy watering each day, as the sprouting grass requires constant moisture. When the new grass is 2 inches high, it should be cut with a good sharp-bladed mower, using the catcher wherever possible.

LOCOMOTIVE

Fireless, Reduces Operating Costs

FIRELESS locomotives, described in some detail in Scientific American, January 1941, are finding increased uses in many industries where they offer a reliable means of



Runs on stored energy

cutting switching and materials handling costs. One type, illustrated herewith, made by H. K. Porter Company, Inc., operates on steam charged into it at 425 pounds pressure. This steam is delivered to the cylinder at a pressure of 100 pounds; the locomotive exerts a drawbar pull of 1333 pounds. It is claimed that this locomotive will operate for a working day on not more than two capacity charges.

Of particular interest to industrial plants where fire hazards must be carefully considered, fireless locomotives offer advantages of not contributing to these hazards and of being explosion proof since excess boiler pressures are impossible.

The initial cost of Porter fireless steam locomotives is less than that of other types of locomotives of comparable power. They are said to have a longer life than other types and hence a longer write-off period for depreciation. Other advantages claimed include low operating costs and an availability factor of 99 percent.

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TAXES—Motor vehicle owners in the United States pay nearly two billion dollars in special levies on their automobile equipment and its operation each year.

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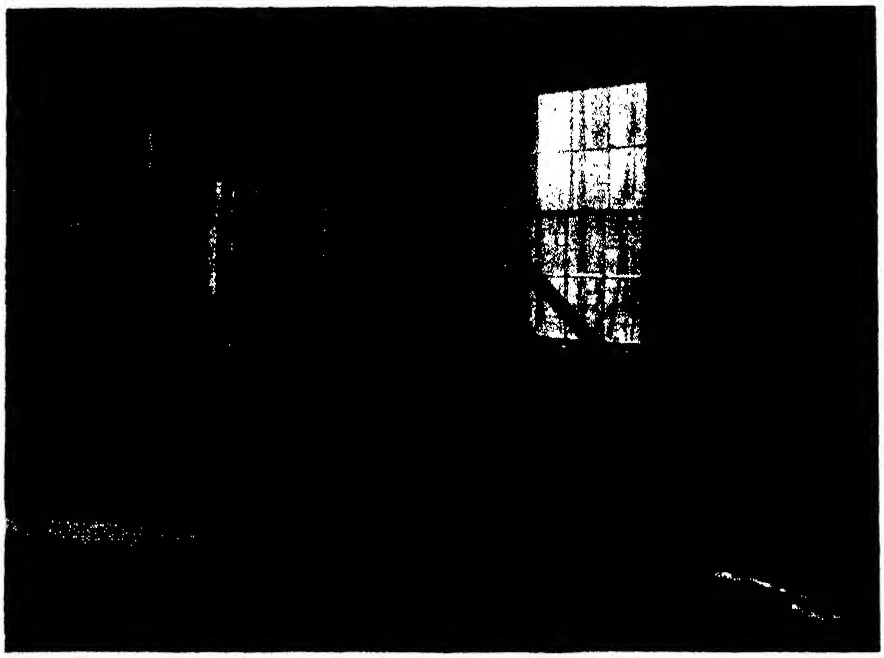
GAS MASKS

Status of Production for Civilian Use

QUERIES addressed to the editor of Scientific American regarding the availability of gas masks for possible civilian use in this country in case of an emergency prompted correspondence with the War Department. Investigation revealed that educational orders for "noncombatant masks" have been placed with five different commercial establishments in this country.

These educational orders provide for the manufacture of a limited quantity of low-cost gas masks of a type designed to meet the requirements of a military commander in providing gas masks for noncombatants remaining in areas under military jurisdiction and control.

This mask provides protection against all known war gases in the same manner as does the service gas mask issued to troops. It is not, however, designed for the long life and rugged use of the service gas mask. It is, the War Department believes, a mask that would be suitable for general civilian use if necessary. At the present time, the War Department states, "no further extension of the manufacturing facilities for these masks is contemplated."



Its business is to wear out floors and floor coverings

FLOOR COVERINGS

How Materials are Tested Mechanically

IN A SERIES of tests recently conducted by the National Bureau of Standards on the durability of a variety of floor coverings placed over different types of floors, a specially constructed test chamber was employed.

The floor-testing chamber contains a circular track four feet wide and approximately 40 feet in diameter in which were installed sections of concrete, strip-wood, and plywood subfloors, and the various floor coverings. The floor coverings were subjected to 48,000 passages of a two-wheeled platform truck, a "walking wheel" four feet in diameter, and two casters. The truck carried a total load of approximately 1100 pounds and was equipped with a steel-tired wheel and a rubber-tired wheel. The walking wheel, loaded to approximately 275 pounds, was shod with eight wooden blocks which were covered with leather during the first half of the test and with abrasive cloth during the second half. One caster was a steel wheel of two-inch diameter and the other a one-inch steel ball. The equipment traveled around the track at a speed of about two miles an hour. The floor coverings included linoleums in sheet and tile form, cork-combination tiles, sheet rubber, rubber tile, asphalt tiles, fiberboard tiles, felt-base floor coverings having various wearing surfaces, three monolithic floors, and a number of wood floors. The bonding agents were lignin pastes, cumar-resin cement, alumina cement-latex paste, rubber cements, various asphaltic adhesives, and nails.

Complete results of the tests, with photographs, are given in bulletin BMS68, available through the Government Printing Office at 15 cents.

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SMOKING SIRUP: One fourth of all the maple sirup produced is used in the tobacco industry and nearly all of this is purchased by one company.

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CAULKING COMPOUND

Applied Without Tools, Easy to Handle

A SEALING and caulking compound, called Kalk Kord by the manufacturer, Presstite Engineering Company, is a plastic, non-oxidizing compound that, it is claimed, will not check crack or harden. It can be easily applied without tools to caulk window and door frames or to seal cracks in wood, plaster, and

so on. Kalk Kord is simply applied with the fingers, being pressed into the opening to be filled. It is packed in convenient rolls, so that application consists merely of pressing a length of the cord-like plastic substance into place.

It is clean to handle, grayish-white in appearance, can be painted over immediately and will not stain paint. Because it always remains plastic, Kalk Kord will not crack with temperature changes or expansion and contraction of surrounding areas. It is waterproof, and can be used in the bathroom to seal cracks in fixtures, around tub edges, and so on.

PLASTIC PAINT

Protects Dials on

Electrical Instruments

A NEW white plastic finish, capable of resisting indefinitely the combined attacks of high temperature, corrosive fumes, and humidity, will protect dials on the latest type in-

Stays clean

dustrial and military instruments. The new finish, developed by engineers of the Westinghouse Meter Division, eliminates destructive discoloration of dial faces which often hampers emergency reading of instruments vital to the safety of industrial machinery, tanks, aircraft, and ships.

The "world's worst weather" has been created in the laboratory to test the new plastic. Finished dials were placed in chambers where the heat and humidity of the tropics and the cold of polar regions were reproduced artificially. Biting salt vapors simulated conditions at sea and along certain coastal areas. Oil and tar smoke were used to determine whether the dials would remain pure white in their glass-enclosed cases when placed in factories and in the engine rooms of ships. Other tests revealed that the finish is resistant to gaseous fumes encountered in industrial and military service.

In a series of experiments ordinary dial lacquer changed to light coffee brown after 10 hours of exposure to dry air at a temperature of 317 degrees, Fahrenheit. Fumes from heated raw phenolic plastics changed white to straw color after 120 hours. Dials were mottled with yellow splotches after 100 hours of saturation in a sulfur-dioxide atmosphere. Plastic-coated dials remained unchanged under identical conditions.

Metal dials are coated by an automatic spraying process; lettering is done by a printing process using specially prepared inks. Accuracy required in electrical instruments makes it necessary to print dial markings with a variance of less than 5/1000ths of an inch.

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MOSQUITOES—There is no royal road to mosquito elimination, according to entomologists of the Department of Agriculture. Carefully planned action against the breeding places is the only dependable control measure. This should be supplemented, however, by thorough screening and the use of sprays and repellents.

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HOME SYPHON

Uses Any Bottled

Carbonate Beverage

DOUBLE advantages are to be found in a newly designed device for dispensing carbonated beverages from the original container. First, dispensing is made easier, and second, the bottle remains sealed at all times, the contents retaining its "pep" until used.

A good mixer

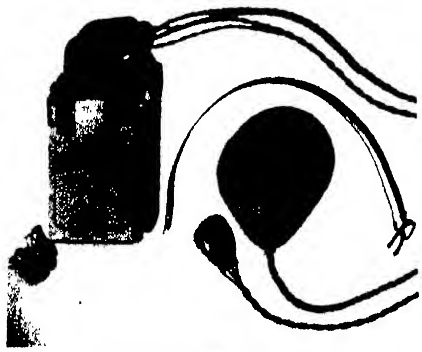
The dispensing device, known as Soda-Mizer, consists of a tube which is inserted in the bottle after the crown cap is removed, terminating in a plastic cap which houses a simple yet effective valve mechanism. A wire clamp holds the unit firmly in place. After the bottle is sealed with the Soda-Mizer, it is only necessary to press the button on the top of the unit to draw a stream of the carbonated beverage.

BATTERY

Rechargeable Unit

For Hearing Aids

ENCASED in transparent Lustron, a plastic which is not affected by strong acids, a new rechargeable battery is now available for use



Liquid type, yet safe

with various types of hearing aids. Known as the Wheat rechargeable battery, it is light in weight, compact, and yet is reported to have ample power for the purpose.

GLASS RECORDS

Replace Aluminum

Sound Recording Discs

HIGH quality sound-recording blanks using a plate glass base are now available on the market. These disks are being manufactured by the Presto Recording Corporation to replace the aluminum base disks which were generally used in the past.

The new record is .104 of an inch in thickness; the coating compound which serves as the recording medium adds to the durability of the disk. Breakage is reported to be no more of a problem than with ordinary commercial phonograph records. The holes for the turntable shaft and the cutting mechanism drive pin are bushed with soft brass eyelets to insure a snug fit and to prevent chipping.

Industrial Growth

New Products and Processes That Reflect Applications of Research to Industrial Production

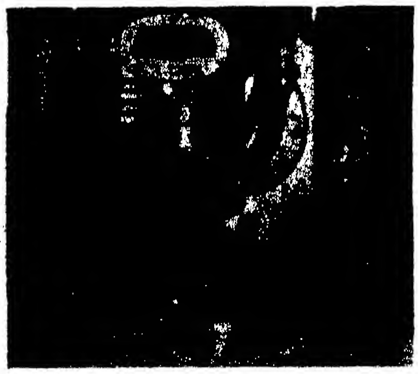
Insulation is stripped clean

INSERTED BLADES

Standard Tools

Speed Production

STANDARD low-cost Carboloy turning, facing, and boring tools, which are now available on the market, are being adopted by a number of manufacturers, including the C. A. Porter Machinery Company, producers of industrial machinery. By



Cutters that use standard tools

using such standard tools, which are manufactured on a mass-production basis, it is possible to avoid delays incident to design and production of special tools or blades. In many cases the standard tools can be used without alteration; at most it is necessary only to cut off the shanks and perhaps regrind the cutting edges.

One of our illustrations shows three multi-blade cutters of which the bodies are made by Porter. These bodies are then assembled with the inserted blade cutters in the company's tool room, after grinding the standard tools to be used.

EFFICIENCY

Handling of Materials

Expedited Simply

MORE than 1000 parts and 75 different materials are used in the assembly of a De-ion motor line-starter in one of the plants of the Westinghouse Electric and Manufacturing Company. These parts are assembled by means of an electrically operated nut driver. To simplify assembly operations the parts are placed in the fan-shaped arrangement shown in one of our photographs and the nut driver is suspended from a vertical spring to remove it from the point of application when not in use.

WIRE STRIPPER

Electrically Heated

Blades Remove Insulation

A DEVICE for rapidly stripping cotton, silk, and rubber coverings from wire, known as the Ideal Hot Blade Wire Stripper, announced by the Ideal Commutator Dresser Company, operates with blunt blades. Thus there is no possibility of cutting the strands of fine wire or of injuring the conductor in any way.

The wire is merely inserted between the electrically heated blades in the stripper head. Pressing the foot pedal brings the blades against the insulation and instantly two parallel grooves are burned right down to the conductor. The grooves are completed with a slight twist to right or left; a pull removes the insulation, leaving a clean edge. With a little practice the twist and pull become practically a single movement. The strippings fall into a water drawer where any burning particles are quickly extinguished.

Each blade has an individual heat control and transformer so that the burning temperature of each can be separately raised or lowered as desired, depending upon the type of insulation and thickness. Both the distance between the blades, and desired length of stripping are quickly adjustable.

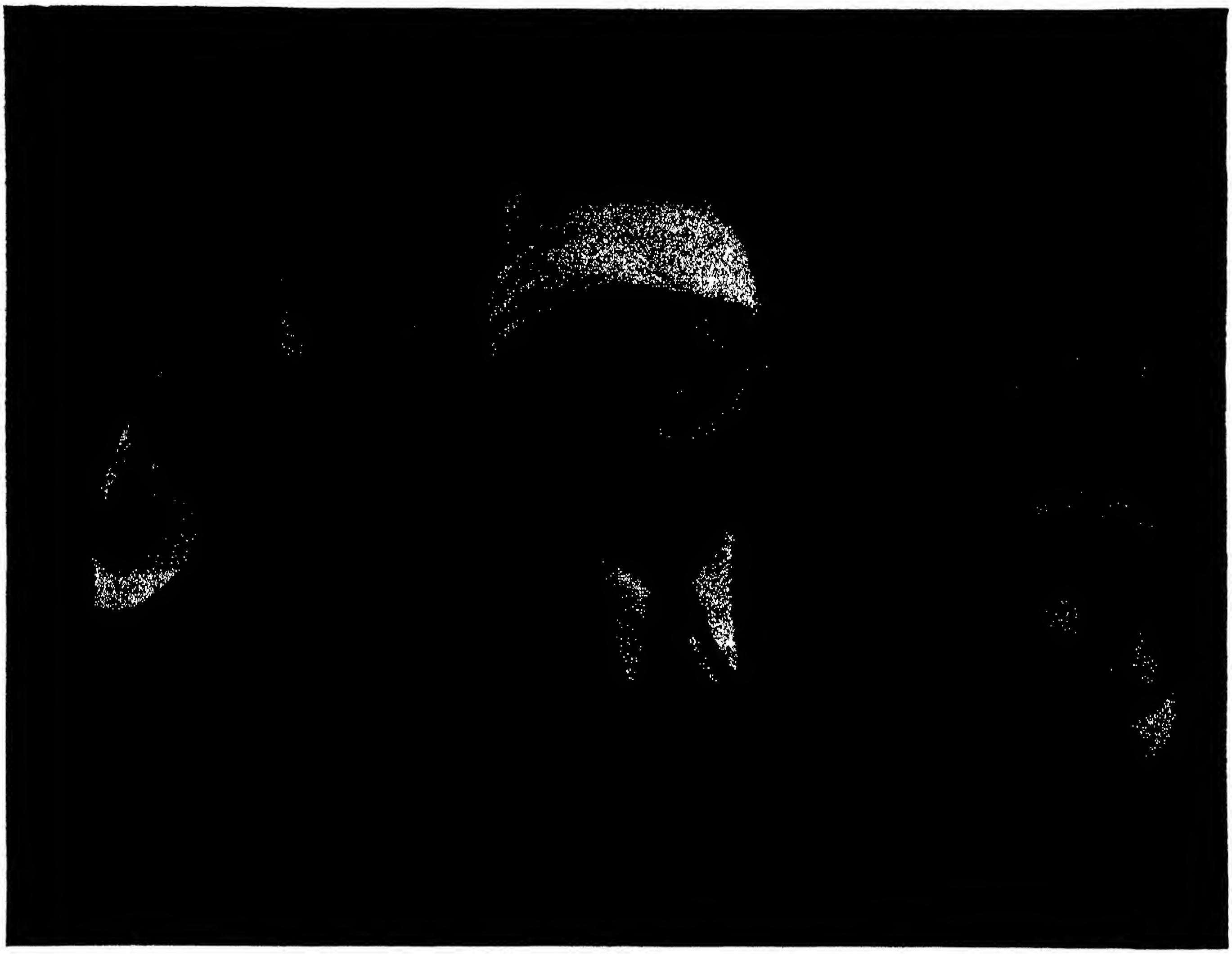
GASKETS

Synthetic Rubber

Proves Satisfactory

FOR keeping grease and oil confined in bearings in various types of machinery, gaskets made of Ameripol, the synthetic rubber developed by the B. F. Goodrich Company, is proving highly successful. Tests show that the gas-

Parts for assembly are placed within convenient reach of operator

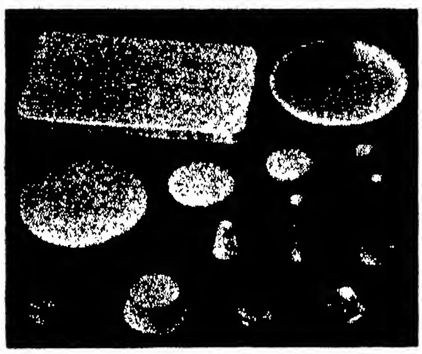


kets do not swell at all in gasoline at room temperatures, and that after immersion in oil for long periods they do not swell materially. A high degree of flexibility and abrasion resistance is found at all times. These gaskets are made by either the molded or lathe cut methods.

FILTER, DIFFUSER

Made from Powdered Metal, Has Many Applications

REPRESENTING what is described as a new technology in control of filtration and flow of liquids and gases, a porous metal product known as "Porex" has just been introduced by Moraine Products Division of General Motors Corporation. Porex has two principal functions: to remove foreign materials from fluids, such as oil; and to alter the characteristics of gases by diffusion, reducing pressures and controlling flow rates. The new filter and diffusing material is manufactured from powdered metal subjected to a series of processing operations.



Standard shapes of metal filter

Applications for Porex are possible in almost any appliance or piece of industrial equipment involving the flow of gases or liquids. These uses are found in pumps, refrigerators, fuel lines, lubricating systems, oil burners, evaporators, absorbers, paint sprayers, premixed gas burners and other devices.

This new material, for example, is used to prevent clogging of orifices in Diesel injector nozzles with effective removal of fibrous materials not stopped by other types of filters. It also acts to prevent a drying agent from passing from its chamber into a refrigeration system when the refrigerant passes through it to be dried. An additional use is in separating oil, moisture, and solids from air supplied to paint spraying equipment.

The characteristics of Porex, such as chemical composition, structure, porosity, strength, and ductility, may be varied within certain limits to suit specific applications. Similar variations may be accomplished in its size and shape. Standard shapes now available are disks, sheets, cylinders, and truncated cones, while special shapes also are obtainable.

PAINTS

Black and Aluminum for Hot Surfaces

METAL surfaces which are subjected to intense heat can be adequately protected with one or the other of two new paints recently announced by Thurmalox Company. One of these paints, available in black, is intended for use either indoors or out and will withstand temperatures up to 1600 degrees, Fahrenheit. The other paint, in aluminum finish, is for indoor use at temperatures up to 1200 degrees, Fahrenheit.

Either of these paints can be applied by brush or spray to hot or cold surfaces that have been cleaned thoroughly.

EYE SHIELDS

Flood-Lighted, For Use With Shop Grinders

AN ILLUMINATED eye shield which is suitable for use on all types of bench grinders has just been an-

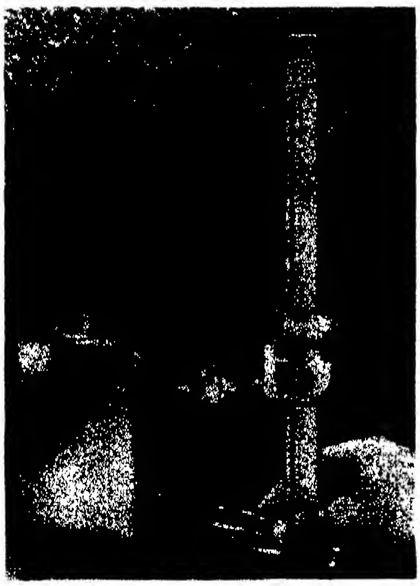
Safety in grinding

nounced by the Stanley Electric Tool Division. Known as the Flud-Lite eye shield, the device is fitted with two bayonet type light bulbs located between two sheets of glass. One of these, a piece of ordinary window glass, is located adjacent to the grinder wheel and can easily be replaced when it becomes pitted. The other sheet is of safety glass which provides ample protection for the operator. The two bulbs throw light directly on the grinding wheel and the work, providing 30 percent more visibility than previous models. The complete eye shield unit is adjustable and can be arranged to suit the operator's position. It cannot, however, be moved to a non-guarding position without dismounting.

MAGNETIC

Holding Tool For A Variety of Jobs

NEWLY designed, a precision holding tool of the permanent-magnet type is now available in a small and convenient size. The height of this V block is 3¼ inches, it is 2½ inches wide over-all, and has an over-all length of 6¼ inches; the capacity of the V diameter is 1¾ inches. It is designed for holding iron or steel work of round or rectangular cross-sections as well as irregularly shaped pieces which can be placed between and in contact with the V faces. The permanent-magnet construction of this block is such that, by turning a knob on one end of it, the flow of magnetic flux through the V can be controlled from full "on" to full "off". If the



Magnetism holds parts

end of the V block is placed on a magnetically conductive surface, block as well as work are held firmly until the control is turned to the off position. By reducing the holding power work can be removed from or re-positioned in the V without releasing the block from the conductive surface.

THWARTS EXPLOSIONS

Conductive Rubber for Cart Tires

STATIC electricity, generated by the operation of carts carrying materials in factories, often reaches such intensities as to create spark dis-

Rubber tire conducts current

charges. These sparks can constitute an extreme hazard in armament factories and other places where ammunition or other explosive or inflammable materials are present. To eliminate this danger, B. F. Goodrich Company is producing tires for industrial carts which are made of rubber that has been transformed from one of the best electrical insulators into a conductive compound. Static charges pass through these tires before they can reach dangerous concentrations. One of our photographs shows a simple test of a conductive rubber tire; current is conducted through the tire and lights a small lamp in the circuit.

PAINT REMOVER

For Stripping Painted Steel and Iron

USED in a solution tank at 210 degrees, Fahrenheit, a new paint remover in semi-paste form quickly strips paint, lacquer, varnishes, and

so on from steel and iron parts. The semi-paste is dissolved in water in the proportion of approximately eight ounces to one gallon of water. It is claimed that this material, known as D. C. Stripper, manufactured by D. C. Cooper Company, is economical to use and works faster than any available liquid paint remover. It is easy to rinse, gives off no offensive odor or fumes, is non-explosive and non-inflammable.

BLACK STEEL

Lustrous Finish

Produced By Immersion

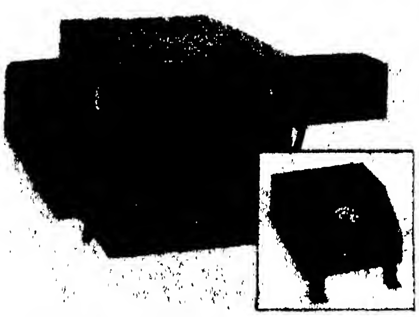
WHEN steel parts are immersed in a solution of water and Houghto-Black salt, at a temperature of 290 degrees, Fahrenheit, a lustrous black finish is produced, without, it is claimed, any change in dimension of the parts. Before the dipping operation is performed, the parts must be made chemically clean.

SMOKE DETECTOR

Photo-Electric Cell

Controls Equipment

MORE accurate control of combustion in all types of industrial boilers is possible when a photo-electric cell detector is employed to indicate the presence of excessive smoke in the flue. Two such units have been made available by the Rehtron Corporation, one of which gives any desired type of signal when smoke in the flue reaches abnormal density. The second type is provided with an automatic



Smoke detector mounted in stack and (inset) control box

mechanism which will go into operation when smoke becomes excessive and will operate controls to correct the condition.

These units are stated to be easily installed and adjusted and can be applied to any type or size boiler, whether stoker or hand-fired coal burning or oil burning.

Washington National Airport

Designing Engineers Have Created the World's Finest Port for Air Transport Lines

ALEXANDER KLEMIN
Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University.

FOR FIRST hand information on the new Washington National Airport, now open to air traffic, we are indebted to General Donald H. Connolly, Administrator of Civil Aeronautics. Located at Gravelly Point, only 10 minutes drive from downtown Washington, the National Airport covers 720 acres, of which 325 is filled in marsh, and is larger than La Guardia, Le Bourget in Paris, Croydon in London, and Schipol in Amsterdam. Only Tempelhof in Berlin exceeds it in area, and Tempelhof is by no means as well equipped. At the new Washington Airport, the weather conditions are generally good and there are clear approaches from at least eight directions with gliding ratios of 40 to 1.

One of our photographs is a view from the north, showing the sweep of the Potomac 'round the Point and the criss-crossing runways which allow landing or take-off into the wind, whatever the wind direction may be. While the Terminal Building is truly functional, the architect, H. L. Cheney, has not neglected beauty, as so many modern architects do when an industrial or transportation building is involved. Not even at Tempelhof are there more convenient arrangements for the public. There will be parking space for 5000 cars. Splendid terraces give a complete view of the field. Each airline has its own individual ticket booths. There will be as many facilities, as many stores, barber shops, and what not, as at Grand Central Station. Air travel has come of age.

But, of course, the general convenience of the public, however important, is less important than efficiency in traffic control. Here the design engineers have surpassed themselves. The Control Tower is a result of the co-operation of practical air-traffic control men at various airports, and of the skill of a group of glass, lighting, and radio experts. The walls of the tower are all of glass, with the upper and lower halves of each wall set outward at an angle of about 90 degrees to each other. This setting avoids all reflection of ground lights, plane lights, sun,


Washington Airport, upper center, as seen from the north

In the Washington National Airport control tower

Wheel of a transport plane on the round iron saucer of the turntable

moon, and stars. As one of our photographs shows, each section is fitted with a window wiper, operated manually from inside. The glass is heat-absorbing, excluding the heat of the sun and retaining inner heat. Radio equipment in the tower will provide two-way communication with planes and an automatic device which makes a record of every conversation between the tower operators and pilots. A special electric bulletin board will give instantaneous information on plane movements. The board is an adaptation of automatic stock quotation apparatus, and cryptic numbers will tell the control room everything about plane movements at local and distant points.

But reliance for local traffic control is not placed solely on radio communication. Visual instructions to the pilots for all landings are provided by a system of lights on the field. Approaching at night, the pilot will see one particular runway outlined with lights placed every 200 feet. At the approach end of the runway which he is to use there will be a large arrow in green neon lights, indicating the direction which he is to take in landing. If the pilot is to circle and wait further instructions, a flashing cross in red neon lights appears. On the illuminated runway is a plume of white smoke coming up out of a submerged smoke pot and blowing along the surface with the surface wind. The field is in complete darkness except for the boundary lights and those giving landing instructions. When he has landed, the pilot sees a string of blue lights visible only from the ground which lead him to his proper position on the loading area. This system permits simultaneous takeoffs and landings of several planes.

Visitors to airports marvel at the dexterity with which pilots maneuver huge transport planes, bringing their wheels onto narrow alleys painted on the concrete. This procedure is not difficult, but when the plane must turn a complete circle after it has taxied to the loading station, there is a severe strain on the tire and landing gear of the wheel used as a pivot. Turntables at the Washington Airport are designed to avoid this difficulty and make the correct positioning of the plane easy and efficient. Each turntable consists of a circular iron saucer, six feet

in diameter and cupped in the center. This saucer is mounted on 16 rollers resting on a supporting circular track below. The pilot places his wheel in the center of the saucer, locks it with his foot brake and then swings the plane around by giving thrust to one of the propellers only. The huge plane swings 'round readily on its saucer pivot.

There are many other products of engineering science to be seen at the Airport. Sufficient has been said, however, to indicate that American designing engineers have risen nobly to the demands of the situation, and airport design has now attained the same high level as the design of the transport planes themselves.

FLIGHT TRAINING

Man-Made Gale For Gliding

Large airplane propellers mounted on stripped truck chassis and driven through a power take-off are now being used to provide man-made gales to aid in training glider pilots.

As two of our photographs show, these propellers force air through a honeycombed structure which "smooths out" the air flow and prevents disturbances that might render the system ineffective.

These gale-producing units, known as Wind Charger Wagons, were invented by Commander E. F. McDonald, Jr., President of Zenith Radio Corporation and author of the article "Pilots, Pilots, More Pilots" which appeared in the July 1941 issue of Scientific American.

By the use of two or more units, a glider can be flown while anchored to the ground by 100-foot ropes. It can be maneuvered up and down in the wind stream, responding to the ailerons and elevator much as in free flight. Thus the student is enabled to learn the use of the controls and the feeling of flight without getting more than ten feet from the ground. Much of the danger of preliminary training is therefore eliminated and instruction work can be carried on regardless of weather conditions. In one test, a young woman with no

Above: **A glider taking-off in the man-made gale supplied by the Wind Charger Wagons.** *Below:* **Facing a flying glider; Wagons in foreground**

A Baltimore Medium Bomber, versatile warplane for the RAF

previous flying experience, and who couldn't even drive an automobile, was able to fly a glider alone after only ten minutes of instruction.

BALTIMORE BOMBER

Production Design Has No Prototype

THE Martin 187, or Baltimore Medium Bomber, is a splendid addition to the equipment of the RAF. According to Glenn L. Martin, president of the manufacturing company, the new bomber is expected to "prove superior to any aircraft of its type now flying in Europe and to out-perform many of the latest pursuit types in actual combat." The Baltimore is versatile: it can bomb, undertake reconnaissance, and put up an excellent fight with its heavy armament and a power-driven gun turret. It is powered with two Wright engines of 1600 horsepower each and will carry a crew of four. The nose is entirely of plastic, providing excellent vision for the bombardier.

It is extraordinary that the Martin 187 has no "prototype." The first airplane, now going through its tests, is the first of the production series, with regular delivery schedules to begin in a few weeks from a shop covering 15 acres of floor space. We did not believe it possible to eliminate the prototype. Evidently the engineers now know their job so well that "fussing" is no longer necessary.—*A. K.*

STRATOSPHERE COMFORT

A COMPREHENSIVE study of passenger cabin supercharging was recently presented by James B. Cooper, of Boeing Aircraft, in a paper read before the S. A. E.

High-altitude flying is impossible with ordinary human machinery. Normal individuals require additional oxygen if they remain for any length of time at altitudes of 12,000 feet or more. The use of the oxygen mask is clumsy and unsatisfactory. It would be almost impossible to instruct all the passengers in an airliner in the correct use of an oxygen mask. The provision of an oxygen compartment into which oxygen is sprayed is just as unsatisfactory. There is no satisfactory solution, Mr. Cooper concludes, and we agree with him, other than the use of a supercharged cabin, and the art of supercharging a cabin is quite a complicated one. A Roots blower or a centrifugal compressor is necessary. Either type of supercharger should be driven from the main engines and variable speed drives (now being developed) would be very helpful. Unfortunately, when the air is compressed for delivery into the cabin, it is also heated, so that coolers must be provided. Airline passengers would not be very happy if supplied with air 60 degrees, Fahrenheit, above normal temperature.

The cabin is not supercharged to sea-level pressure, because that would give a very high pressure differential and the structure of the fuselage would have to be very heavy. Hence, if flying is to be undertaken at an altitude of 20,000 feet, the inside pressure is equivalent to an altitude of 12,000 feet. Even this gives an outwardly bursting pressure of 2½ pounds per square inch of fuselage surface. The fuselage has to be of circular section, carefully reinforced, with plenty of tape to seal the seams. The windows, of laminated glass and Plexiglass, have to be immensely thick. All doors are provided with gaskets, self-sealing under the influence of cabin pressure. Special valves have to be provided to control the flow of air and its pressure.—*A. K.*

Conducted by JACOB DESCHIN, A.R.P.S.

Theme Sequences for Your Movies

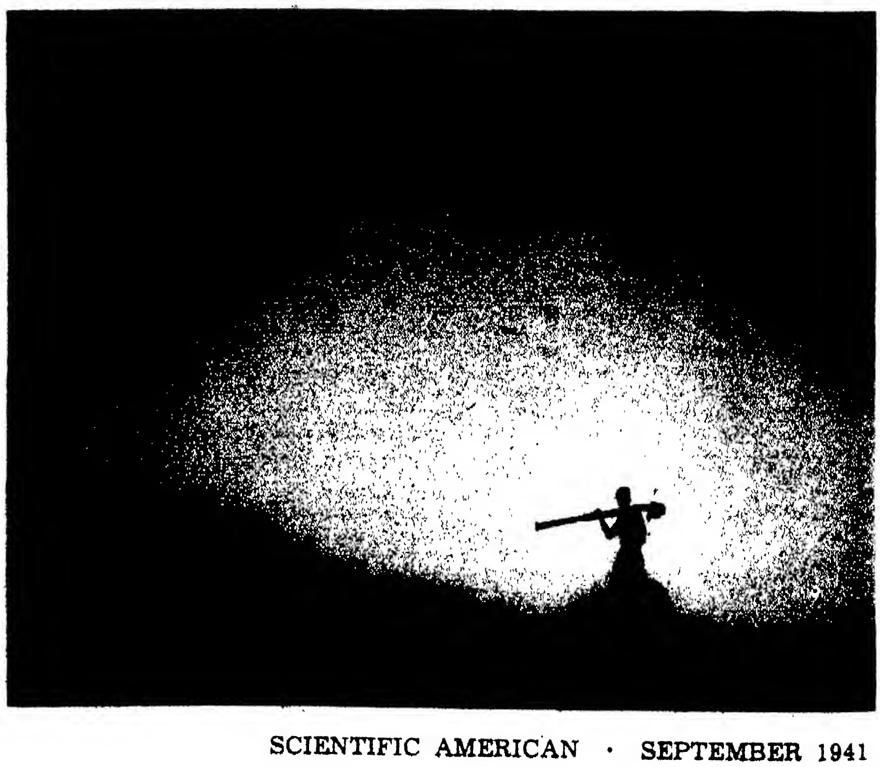
PLANNED movie stories of an incident or home movie play can be made to run more smoothly, and with scenes tied to each other more convincingly, without abruptness or lag in interest, by the judicious use of thematic sequences. These sequences do not necessarily have anything to do with the action of the story; if they supply atmosphere and mood in keeping with the story, they will do their intended job.

Theme sequences have many places —at the start, at the end, and in the course of the film. They can, for example, be used to denote the lapse of time more effectively than a mere title, that says "The Next Morning." A scene actually showing the passing of the day and the sun rising the next morning, will be much more appreciated by the audience. In such a case, a title may often be dispensed with entirely, because the picture itself has indicated the passage of night and the dawn of a new day.

Starting a film story often is a stumbling block for the scenarist. Where to begin without giving the audience the feeling they are being dropped right into the action without warning? Film makers are familiar with many devices in this connection that do the job satisfactorily. When in doubt, try some such scheme as that suggested by Figure 1. What could be more appropriate for a bird filming, for example, than to lead the viewer into the story by following a bird track? Or, in another situation, a narrow, winding road through the woods? Not only does one build up the all-important suspense so valuable in film-making, but atmosphere, mood, and locale are also identified.

Another stunt was recently successfully accomplished on a picture-making trip of a cine photographer and a still shooter. The former, using an 8mm camera and carrying little other equipment, was able to stride across the dunes at a much faster pace than his companion, who carried a large camera on a tripod slung over one shoulder, besides other equipment.

Figure 1 (above). Figure 2 (below)



At one time, the movie man, way ahead of the other, stretched out on his tummy and aimed the camera towards his approaching friend. He started filming when the latter was quite a distance away and therefore a very small figure on the film and continued running film until the subject came within fairly close range. Such a scene might be considered part of the story, but it serves very well, too, for striking the theme of an incident about to begin. The same story might end with such a logical finish scene as Figure 2, which was photographed against the sun, the figure of the photographer blocking the actual sun as it neared the horizon.

Figure 3 would fit perfectly into the story of a fishing trip. It has the quiet, restful atmosphere congenial to the fisherman's mood. The reflection of the moving white clouds in the calm water, the grasses scattered helter-skelter throughout the foreground, the feeling of complete inactivity, might presage the start of the trip or portray the end of one. Such a scene could be used somewhere in the middle of the day's venture, with all hands out for a fish fry on the river bank. Incidentally, it would be very useful in a fishing trip story which netted little if any fishing activity, but plenty of rest and quiet!

Figure 3 (above). Figure 4 (below)

The exciting movie story could well profit by such a sequence as Figure 4, affording a delightfully restful pause in the action to give the audience a chance to catch its breath and appreciate the beauty of the locale. Scenes like this need a filter, of course, but the all-round favorite medium yellow, if used in the later afternoon, will do the trick as well as an orange or a light red earlier in the day.

Theme sequences need not be made at the time of the actual filming of the story, but may be spliced in from parts of films made before or after the film has been made. It is a good plan to be on the lookout for thematic subjects for future incorporation into stories. Standing alone, such scenes may not amount to very much during a brief showing on the screen, but spliced into the run of a full story, will give body and movement that might otherwise be lacking.

Spotting Colors for Glossies

For testing one's patience, there are few tasks in photography more exacting than spotting a glossy ferrotyped print having small white marks all over its surface, including small hairlines. It is not often you come across such an imposing job, but when you do, it's work. Be prepared to spend anywhere from one to two hours on the one print. Despite the glossy surface, the spotting color will take without too much urging. Use a No. 2 sable brush, wet the brush on the tongue (saliva is par excellence for the purpose) round the tip of the brush into a very fine point on the edge of a card and pick up the color (a mixture of the black and the white

pigment to the shade of gray required to match the tone of the area surrounding the white spot). Then apply gingerly, a very, very little bit at a time, until the spot disappears—that is, merges in tone with the surrounding area.

Camera Finders

DO NOT be alarmed if you suddenly discover that the finder or finder mask on your camera does not give you the full image you get on the negative. This is intentionally so designed in order to make sure that you get everything the mask reveals. It is the safety factor to guard against the possibility of error when viewing the subject through a finder. A masked field slightly smaller than the actual image on the negative is the rule.

Movie as Record Camera?

ONE chap we know, who works both movie and still cameras, frequently makes it a practice when away on a trip to make his record shots with the movie camera, using the still for pictorial work. The idea appears to have some merit for the obvious reason that if the full report of the incident is wanted, the movie camera certainly can do the job more faithfully than the still. No matter how many shots were made with the latter for the sake of telling the story completely, there still would be gaps in the story due to the lack of continuity.

Cleaning Condenser Lenses

WHEN was the last time you inspected the condenser unit in your enlarger? If your prints have lately been going rather sour on you, lacking snap and pep, it is very possible that your condenser lenses have accumulated some dust, which will get into the enlarger housing and, willy-nilly, on the lens surfaces. Take them out, remove the fine dust gently with a brush or cleaning tissue, then polish with a soft cloth. There's more than a chance that this little job will improve the situation considerably.

Polaroid Skies

FOR general use, the Polaroid screen appears to have its greatest advantage in the control of sky backgrounds and achieving clarity of detail. The commercial photographer uses it chiefly to cut glare, for which purpose it is also ideally suited. But for general amateur work outdoors, the dark or medium gray skies achieved with this screen definitely improve the results, both as to sky and as to subject-matter itself. The control of sky tone, moreover, is not limited to a single tone, but varies in effect with the degree of rotation of the screen as well as the nature of the light. When used with Kodachrome, the deep blue sky color obtained is really something, with white clouds stand-

Contrasts from the sky

ing out boldly and dramatically. A single stop wider is all the adjustment required, or, conversely, halving of the shutter speed.

Kodachrome Speeded Up

FORMERLY rated at 5 Weston, Professional Daylight Kodachrome sheet film has been boosted to 10 Weston, thereby bringing the speed even higher than the 8 rating of 35mm Kodachrome Regular. The sheet film starts at 2¼ by 3¼ inches and includes all the professional sizes.

If At Black-and-White You Don't Succeed, Try Color?

"I'M GOING to shoot nothing but color from now on," someone told us recently, "because it looks so much better." There is much to be said for this, but we still are of the opinion that if you cannot make good black and white pictures, your color shots will be bad too. This seems so obvious that it is hardly worth mentioning, yet say it we must because many workers feel this way about it. True enough, color shots have the big advantage of faithful rendition not only of the subject matter but also of the various colors of the subject matter, making the reproduction more true to life. But the mere achievement of color does not make a picture. Color or black and white, there is always composition, worthwhile subject-matter and all the other things that go to the making of a good picture. So never believe that you can step from bad to good photography just by using color film.

Substitute Measures

IF YOU are constantly using specific quantities of particular chemicals; for example, ¾ of an ounce of sodium bisulphite to mix with a quart of plain hypo for use in place of the usual acid hardener bath, weigh out this quantity on the scale, as usual, then pour it into the bottle cap. Shake the cap

gently to level the chemical and note the leveling off point on the threads of the cap. Thereafter, all you will have to do to measure out this quantity will be to pour the chemical into the cap until it reaches this level.

Cowboy Photograher

GREATER love hath no camera than that its owner is willing to forego the attractions of modern conveniences for the sake of an old friend that has been performing faithfully through the years. Back in 1909, Charles J. Belden, rancher-photographer, now famous as "the cowboy photographer," bought a 4 by 5 Carl Zeiss Minimum Palmos camera. He still owns it and uses it from the

"The Trail Herd"

unique vantage point of the back of a horse as he rides in search of pictures over the 40-mile Pitchfork Ranch that he owns in Wyoming.

"The Trail Herd," reproduced here, and one of the pictures illustrating our lead article, are typical of his work—cattle herds, cowboys, dramatic sky backgrounds. Belden invariably wears a ten-gallon sombrero. This does double duty—as a hat and as a sunshade for his camera. Shooting against the sun and in other situations where there is danger of side light striking the lens, Belden has an advantage over most photographers.

Double-Toning

WE DIDN'T like the results obtained on Cykora paper in the gold toning bath we used, so we tried this stunt: We bleached out the black image in the following bath:

Water	16 ozs.
Potassium ferricyanide	½ oz.
Potassium bromide	½ oz.

To the sepia image that remained we added more tone by immersing the print in the Develochrome Sepia bath. The result was a rich brown that we liked very much.

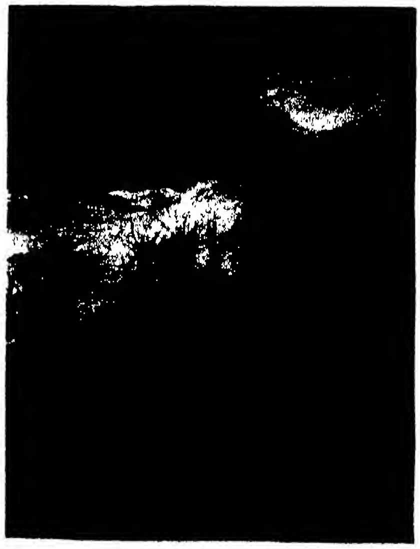
You Can Sell Your Kodachrome Slides

OUR pin-money-making colleagues who have been wondering how to cash in on some of their 2 by 2-inch Kodachrome slides will be glad to know that suitable slides in practically all subject classifications are now sought by a number of firms. These make a number of duplicates of each slide, which are sold in photographic stores to the general public at 50 cents a piece, supplying the maker with one of the duplicates plus a fee for each slide purchased.

The scheme seems to be working fairly well because it is being taken up by one store after another. Sounds to us like a pretty swell way to collect slides for a personal file in the same way movie fans buy or rent movies.

Low-Sun Pictures

OUR experience has been that some of the best picture opportunities come near the end of the day, as the sun approaches the horizon. Aside from the soft light prevailing, this is the time for beautiful sunsets, for fine tone gradations and, above all, for recording studies in texture and long, graceful shadows. The illustration shows one of the possibilities. Composition, as always, helps the picture.



"Sunset on the Dunes"

Here we have a large dark mass in the upper left-hand corner, a highlighted strip of sand making a graceful curve from right to down left, and grasses casting long shadows across the sand.

Cats Quiescent

A FRIEND of ours has a trick with cats that might be useful when you next try photographing that active feline of yours. He plays with it for a while, making it go through some of the most exciting tricks he knows, then feeds it. Being well worn out from the violent exercise and burdened with food, it is ready for sleep. This is the time for the pictures. Instead of permitting her to go to sleep, he makes her pose. Yearning for sleep, the cat will do almost anything the photographer desires, having no

will of her own at this point. He finds this routine invariably successful.

Here is another method. The cat in the illustration loves to be caressed, when it will fall into complete relaxation. Sitting in the lady's lap, enjoying the gentle scratching back of the

Feline relaxation

ear, will keep her quiet for picture purposes for some time and supply poses every cat lover will appreciate. If the cat closes its eyes during the scratching, a momentary halt will open them again.

Adjusting Temperature

IN BRINGING the temperature of the film developer up or down, as the case may be, to that required for the film used, it is always advisable to make the final thermometer test in the tank or tray in which development is to take place—not in the storage bottle. Also, give the thermometer a real chance to do its work by waiting a minute or so for the true reading to be reached.

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WHAT'S NEW

In Photographic Equipment

PHOTRIX 11 by 14 PRINT WASHER ($5.95): Based on "straight-line-flow" principle permitting back and front of print to come in contact with flowing water. Made of heavy Armco Zincgrip, grey enamel finish. Water enters washer through series of apertures at one end and leaves washer through apertures at other end.

DAYLIGHT BLUE SUPERFLOOD PHOTOLAMPS Nos. B1, B2, and B4 (30 cents, 60 cents, $1.75 each, respectively): Designed for color photography. Made of natural daylight blue filter-glass acting as own self-filter to match natural daylight approximately, thus eliminating need for correction filters when taking indoor color pictures with regular professional daylight type Kodachrome film. Bulb inside-frosted to produce soft diffused type of light. Characteristics: B1—250 watts, 3-hour life, approximate lumens 6100; B2—500 watts, 8-hour life, 12,000 lumens; B4—1000 watts, 10-hour life, 23,500 lumens.

ROSS OPTICAL LENS TISSUE (35 cents package): Packaged in vest pocket size Pliofilm pouch, 100 sheets—3 by 5 inches—per package. Manufactured by special process, free from lint or filler. Highly absorbent, removes moisture, oil, grease, fingerprints, and so on. Non-abrasive, made of 100 percent linen stock impregnated with non-staining chemical. High tensile strength.

MACK WIDE ANGLE AUXILIARY 8mm CINE LENS ($21): At present available only for Cine Model No. 60. Ready for instant attachment by screwing into front of regular camera lens, which must be set at infinity. Doubles angle of view. Depth of field two feet to infinity.

MANSFIELD KWIK-WET (35 cents bottle): A few drops added to any paper developer said to result in complete and rapid coverage and even development of print. Similarly, a few drops in any film developer prevents airbells and pinholes. Small quantity in hypo accelerates fixing. As final rinse, added to tray of water, assures spot-free drying. Also aids other processing, such as toning, reducing, and so on. Available in shaker-top bottle containing sufficient material for treating 75 pints of solution.

HYPO-CHEK (30 cents bottle): Warns when hypo is exhausted. Few drops in worn-out fixing bath results in milky precipitate, indicating exhaustion. Shaker-top bottle contains sufficient material for 225 tests.

KODAK 8 by 10 METAL PAPER BOARD: Stationary mask frames paper to actual print size of 7½ by 9½ inches, leaving ¼-inch margin all around. Hinged at rear of base, mask is easily raised by tab projecting beyond base. Concealed spring device holds mask in raised position while paper is placed against guides at left and back. For prints of smaller sizes, two movable masks are used. Small lever for adjusting print margins of ¼ or ½ inch. Board finished in gray lacquer, with base of wrinkle finish. Padded sub-base prevents slipping and scratching.

BROWNIE DARKROOM LAMP MODEL B: Equipped with filter cup of molded Tenite. Lamp screws into any ordinary electric light socket. Lamp supplied with unit, 7-watt, 110-125-volt bulb. Tenite filter cups of three different colors available: red for orthochromatic films or plates; green for panchromatic; yellow for printing and enlarging papers. Easily interchangeable.

YOUR FIREARMS and FISHING TACKLE

Conducted by A. D. RATHBONE, IV

INTEREST IN FIREARMS *is traditional with American men; fishing tackle is a requisite of one of the world's oldest occupations. Scientific development of guns and tackle, in the use of which millions yearly find sport and recreation, fathers this monthly department which welcomes correspondence from readers.*

Remington Solves an Old Puzzle

NOW, AFTER many weeks of widespread speculation by shooters, based largely on incomplete reports that had leaked out about a new gun, the inside story can be told concerning the scientific development and operation of Remington Arms Company's latest addition to its line.

It is a .22-caliber autoloading rifle, known as Model 550. Through use of feature known as "Power Piston," this gun shoots short, long, and long-rifle cartridges interchangeably and without necessity of making any mechanical adjustment. Model 550 is a 6½-pound take-down rifle with overall length of 43½ inches, a 24-inch, round, tapered barrel, crowned at the muzzle. It has a magazine capacity of 22 shorts, or 17 longs, or 15 long-rifle cartridges and is equipped with side-lever type thumb safety; full size, one-piece pistol grip stock; and semi-beavertail fore-end. Gun has white metal bead front sight, new style step, adjustable rear sight, base of which conceals dovetail slot to permit fitting of other rear sights.

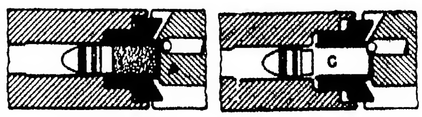
Remington's Model 550 autoloading .22 caliber rifle

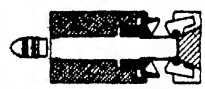
The secret of the adaptability of this new gun to all .22 cartridges is the "power piston," a feature that increases the energy of the .22 short cartridge sufficiently to operate a mechanism which would otherwise function only with the .22 long or .22 long-rifle cartridges.

Shoots all .22 caliber cartridges

The operating energy, or rearward gas pressure of the .22 short cartridge, when used in the model 550, is increased to the equivalent of the .22 long-rifle. In other .22 autoloaders the energy which operates the action is transmitted through the head of the cartridge only. When .22 shorts are used in Remington's new gun, the energy is transmitted through the the front end of the "power piston," as well as the head of the cartridge.

Before firing, the .22 short cartridge is securely held in the chamber by the breech bolt, and the cartridge case extends to the front end of the "power piston." At the instant of firing, gas pressure exerts energy on front end of the "power piston," as and on the cartridge head, and this application of the pressure to a greater area increases the rearward energy and operates the automatic mechanism, which would otherwise function only with the heavier .22 cartridges. As it is necessary to increase the operating energy of the .22 short cartridge only, and as the aid of the "power piston" is not required with long or long rifle cartridges, the chamber is so designed that the cases of the latter two extend beyond the front end of the "power piston," thus blocking off the auxiliary gas pressure.

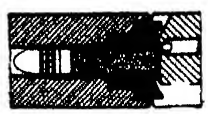




How the "Power Piston" Operates

Upper left: **Breech bolt** *A* **holds .22 short cartridge, case reaches to front end of power piston,** *B*. *Upper right:* **On firing, the gas pressure** *C* **exerts energy on cartridge and front of power piston, thus operating mechanism as indicated, lower right**

The design and subsequent development of the Model 550 began during the summer of 1938 at the Ilion, New York, plant of the Remington Company. During the two years of research necessary to complete work on the gun the major efforts centered



Length of .22 long cartridge case precludes use of the "Power Piston"

around the recoiling chamber and the "power piston," and during that time seven separate models were built before the final approved working model was produced.

Science in Camping

THE RAIN pattered ceaselessly on the tent and the afternoon dragged on interminably. We'd been in camp on a fishing trip with five days of glorious weather and it was irritating to be forced to waste time under canvas when we felt we should be at our primary occupation of enticing bass. There was nothing to read and little to do but cogitate, and in the course of doing so, we came to the conclusion that the advancements of science in many fields have made the camper's life an easier one.

Take the tent, for example. Its light-weight walls, roof, and floor have been waterproofed and keep us absolutely dry; in by-gone days tents had to be made of extremely heavy duck in order to shed rain, and seldom were you dry under foot. Then, the sleeping bags—again a reduction in weight from the old-style blankets and comforters and, with zippered sides and ends, infinitely easier to get in and out of, simple to air, and far warmer if nights are chilly. As for the air mattresses, we now wonder how we ever managed without their bed-like comfort; while balsam bough beds are "romantic" and pleasantly odoriferous, we no longer spend time and energy cutting the boughs, and doubtless much of the young forest growth is saved.

There are also rubber pillows, the gasoline lantern, the electric lantern, the compact and reliable gasoline stove—mighty welcome on rainy days when all outdoors is dripping. Camp clothing has come in for a scientific rejuvenation, as have cooking and eating utensils, all to the end that outdoor life may be more comfortable and more easily enjoyed. Always the trend has been toward greater efficiency and reduction in weight, for portages can be long and weary when all one's belongings must be carted on shoulders in order to reach the desired destination.

In the camp culinary department, however, is found perhaps the greatest advancement. Concentrates of all kinds are available, once more reducing weight and permitting of better and more compact packing. Latest among these are dehydrated soup mixtures, manufactured by DryPack Corporation and packed in Goodyear Tire and Rubber Company's Pliofilm envelopes. The envelopes are four by five inches, about one-half inch thick when filled, and, although they weigh but a few ounces, each holds enough concentrate to provide soup for four persons. All that is necessary is to add the water which, in canned soups may be as high as 80 percent, by weight, of the total, and cook. The average can of soup weighs about a pound and we had packed in seven packages of assorted soup mixes for the same total weight. Yes, we decided, as we lit the portable stove in the comfort of our dry tent and poured the noodle soup mix into a pan of water, camping's different than it was in Dad's day. Science has certainly helped.

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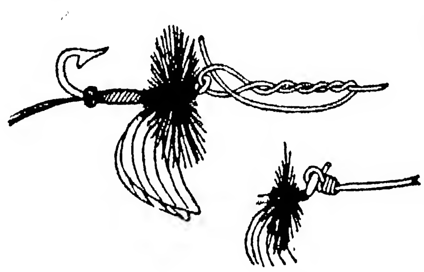
POT SHOTS

At Things New

THE DU PONT COMPANY, as a tail-end-of-the-season suggestion for trout fishermen, offers a new knot for nylon fishing leaders called the "Clinch Knot." All you have to do is stick the end of the tippet through the eye of the fly, double it back against itself for four or five inches, give the fly several complete twists to wind the leader spirally around itself, as shown in upper part of illustration. Thrust



the end between the eye and the coils, hold onto it, and pull up tightly, as indicated in lower part of picture. Other good knots for nylon are the "Figure 8," the "Return," and the "Turle," all shown in the booklet we mentioned in our June issue, "What You Should Know About Nylon Leaders." Want one?

WESTERN CARTRIDGE COMPANY has made another contribution in the field of clay target shooting by re-designing its famous White Flyer target so that it is now reported to be twice as easy to break as formerly. Score marks on the target dome divide it into 16 segments. When target is hit by only a few shot pellets, at least one of the segments will fly out in a piece large enough to score a "dead" bird. Grooves, or score marks reduce thickness along the 16 strips of the dome, and just as glass, scored by the glass cutter, will break along scored line at a gentle tap, so the new White Flyers shatter, even when lightly hit by a few pellets. Re-distribution of weight by making dome segments considerably thicker than is the target at the score marks gives extra strength where stresses occur in trapping. Tumble tests, in which packed cartons were more roughly handled than in shipping, showed reduction in breakage. The new White Flyers are available in the usual wide assortment of colors, and, due to scientific method of re-designing, should enable shooters to "smoke" more targets than heretofore.

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

About two thirds of the telescopes made by amateur workers from the instructions in the book "Amateur Telescope Making" are placed on fixed, permanent pedestals in dooryards. The remaining fraction are portable.

There are three kinds, or degrees, of portability—hand, trundle, and car.

Hand portability: It is pretty difficult to design a rigid reflector of the 6" aperture usually recommended to the beginner without bringing the weight above 50 pounds; usually it will run 100. By reducing the aperture to 4", which still provides an excellent telescope, the weight can be greatly reduced, on the basis that the weight of a telescope is roughly proportional to the cube of the aperture. It is possible to lighten the parts of a 4" telescope enough to permit carrying it like a violin case or midget outboard motor without much sacrifice of rigidity.

Trundle portability: In cases where no permanent pier can be set in the earth, yet where the owner wishes a telescope of 6" or 8" aperture, large casters or small wheels can be added to the mounting of a telescope weighing up to, say, 300 pounds, and it then can be trundled outdoors, set up, used,

Figure 1: **Portable, for the car**

then trundled in again. Numerous solutions of this problem have been published in this column and every maker concocts another.

Car portability: Here weight isn't the main governing factor. The mounting should knock down in about three pieces, yet be settable-uppable without recourse to an erecting crane, and short of half of one night, and be knockable-downable the same. Other-

Figure 2: **Rugged polar axis**

wise, no great compromise on rigidity need be made and the portable can be as useful as a fixed telescope.

Figure 1 shows an 8", car portable designed and made by C. R. Wassell, of the Wassell Manufacturing Co., oil purifiers, Muskegon, Mich. It weighs 150 pounds. Pedestal of 4" seamless steel tubing, welded. At its top, under the head, are beveled filler rings that permit adjustment for latitude, so that the telescope may be used about 2½ degrees north or 2½ degrees south of its home town, simply by adding or subtracting some of these wedge-shaped rings.

The axes are rugged, the hollow polar axis being 2⅜" in diameter at the point *A*, Figure 2, or point of greatest bending moment, and stepped down to 1¼" at the other end. Ball bearing.

In place of the usual central saddle for attaching the tube to the declination axis there is a full-length piece of 1" tubing. At its ends it fits into sockets in the side of cast, machined rings. In these rings the telescope tube rotates, so that stars in awkward positions may be sighted and the finder used, without neck-wringing contortions.

This, then, turns out to be anything but a makeshift type of portable; on the contrary, it is a fine piece of work requiring no small amount of machining—as would perhaps be more evident if it were not, because of its portability, associated with the chicken-foot type of pedestal often seen on less refined telescopes.

It is possible, then, to have a really refined telescope of fairly good aperture with car portability; well, anyway, provided the back-seat driver and family manager doesn't preëmpt the necessary space for other things. But why not design the interior of the tube to be used as a trunk, masculine gender, for sox, spare pants, and so on? Probably good enough for a mere man on a vacation trip.

It's a lot of fun, as any amateur telescope maker will tell you, to invent, design, and then build gadgets to save labor, even if the actual labor saving is a minus quantity. You get your pay when you can step aside and watch them function automatically, with a self-satisfied grin on your face. Who cares about time, anyway

Top-flight position as Public Gadgeteer No. 1 undoubtedly has now been won by Kenneth Richter, 33 Clarence Ave., Bridgewater, Mass., whose star camera works while he sleeps. It is in storage just now, as Richter is away at Harvard and in summer is running a "Chromocinemataudiographic Expedition, Ltd." (possibly "limited" refers to the funds) somewhere between Hudson Bay and the N. Pole. Nevertheless we invited him to remove the bushel from off its light, so the rest of us could see its glimmer. So — — —

Figure 3: **It thinks for itself!**

"The desire for the instrument was born of the fact that we have but two seasons in Bridgewater—the cold season and the mosquito season, and both are too uncomfortable for visual guiding of an astronomical camera. Therefore, about a year's work was spent overcoming the discomfort of attending the camera throughout the night—the exposure is made automatically.

"At about dark, I go out, lift the cover off the instrument, and pull out the plate holder slide against a stop. Next, I go in and set a clock by my bedside for the time I want the exposure to start, also for the length of time it is to run. Then I work on a mirror, take the girl friend to a movie (though building the thing kept me so broke that this is just wishful thinking) or I go to bed.

"At, say, 2 A.M., the clock turns on the power. Outside, the camera springs to life. A small motor swings

the flap shutter open, and an electromagnet holds it thereafter when the small motor has shut itself off by breaking its own circuit just as the shutter strikes the magnet. The latter is energized by a radio 'A' eliminator, to avoid the vibration of the camera that would result from the use of an A.C. magnet. This is a satisfactory source of 6-v., D.C., well filtered. Meanwhile a synchronous motor drive, using one of the hen's-teeth 4-watt Warren motors, has started to apply the diurnal motion.

"Extra features include a Nichrome wire wrapped around the lens barrel, with thermostatic control to keep the entire lens about 10° C. warmer than the outside air. This is adjustable for more heat, in case of heavier dew than usual, but it effectively prevents the condensation of moisture on the glass, and there is not enough heat to distort the image to any measurable degree.

"The 500mm f.1, $f/6$ lens is an anastigmat that would cut a good figure in any company.

"The cross-hairs in the finder have bright or dark line illumination, of which both the color and intensity is variable; color by cellophane filters placed before the bulb (usually red), and intensity by a rheostat swiped from my radio-enthusiast brother's stock of parts.

"Well, the camera purrs along until the clock tells it to shut up. Then the power goes off, the shutter magnet is released, and the shutter closes. The spring that holds the plate holder slide is released, and the slide snaps into place. The drive motor and heater shut off, and, to cap the climax, a counterbalanced cover claps shut on the whole works.

"But suppose I am sound asleep and it rains? Two copper strips placed 1/64" apart and liberally sprinkled with table salt are placed in an exposed position on the baseboard, but at the bottom of a hole so that wind will not blow the salt away. Each of the strips is a terminal in a relay hookup, so that the salt will dissolve in the first drop of rain water, complete the electrical circuit through the adjacent copper strips, and the machine will automatically and instantly close up and go to sleep. A pointer operating in conjunction with a scale on the rim of the polar axis gear also tells, within a minute, how long the camera had operated before the weather forced a shutdown.

"While almost all the gadgets are simple enough to be foolproof in operation, the drive frequently messes up the work. Other than that, one might say that it saves me probably 2 hours' work a week. The number of hours required to build the machine would, of course, swallow up this saving for several years. However, I don't even try to justify it as a net over-all time saver. It isn't.

"But it was fun; and, after all, that seems to be the real purpose of telescoptics."

Figure 4: **Taylor's 100-pound refractor with 3" triplet lens**

CLEAN is the word that characterizes all the telescoptical work of D. Everett Taylor, 191 Prospect St., Willimantic, Conn., some of which has been described here before, also in "A.T.M.—A.", in his chapter on "The Refractor—Metal Parts and Mounting." No exception is his newest telescope (Figure 4) a 3" with a triplet objective of his own make. Invited to describe it, he writes:

"The objective is a rectilinear 3" triplet of 50" f.l., Chance Bros. glass, beautiful stuff. The curves are very flat, the wide field is good to the edge, the diffraction rings are round and concentric, the objective is achromatic and is automatically self-centered. Reason for this type of triplet: reduction of spherical aberration. [So far as is known, Taylor is one of only three amateurs who have made triplets, others being Selby and Grandmontagne.—*Ed.*]

"The 100 pounds of brass shown constitutes a mounting. Base owes its main inspiration to the Springfield mounting. Designed for a permanent base, it is, however, a success on a solid tripod.

"Base of the central sleeve over the main tube is a heavy casting with stud and thumbscrew at either end. Thus the telescope can be disassembled, taken indoors and stored. Note the slot in the *side* of the nearer end of the rectangular declination plate; other slot is in the *end* of same plate. Thus, engage first one stud, then swing into other, tighten up. All set.

"The three layers of the main tube are very heavy, ⅛" wall thickness. All were machined, then lapped to a sliding fit. Draw and focusing tubes ride on the felt in the stuffing boxes." [Explained in "A.T.M.—A."—*Editor.*]

The proportions of this mounting are impressive, and, as usual, Taylor takes a sharply focused photograph that reveals rather than half camouflages the telescope.

LET'S say you wanted some old astronomical book—for illustration, Lowell's "Mars," published 1896—but found it was out of print. You could start out searching all the second-hand bookstores of the nation. This, however, would be something of a job! There's a short cut by which you can do it systematically for something under a dollar and send your feeler into every second-hand bookstore in the land. Have your bookseller or your librarian insert a tiny "book wanted" notice in the weekly book exchange of *The Publishers' Weekly*, wait a fortnight or so and if the desired book is on the shelves of the second-hand bookstores, your bookseller or librarian will begin receiving postal-cards with bids—competitive bids, which keeps the prices down. Then take up the bid you like best and chuck the rest. Your scribe has found it works well.

We did this recently for a reader in the Philippines who wanted to get hold of Lowell's books, "Mars" (1896), "Mars and Its Canals" (1906), and "Mars As The Abode of Life" (1908). We received 11 bids, at prices from $1.50 to $3.50 per book. We selected the ones that looked best and the rest would have gone into the w.p.b., except that it occurs to your scribe that these books ought to be in amateurs' hands instead of gathering dust in musty second-hand stores in various parts of the nation, ultimately to be lost. Interested?

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By Capt. W. D. Puleston, U.S.N.

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Good-Bye to Fuses is a pamphlet published to acquaint home builders and remodelers with "multi-breakers," a new device that eliminates fuses in home electric circuits. *Cutler-Hammer, Inc., Milwaukee, Wisconsin.—Gratis.*

Ventilation and Exhaust Fans is a 16-page illustrated catalog describing a complete line of fans for commercial, industrial, and domestic installation. Information is given on where and how to install fans for maximum benefit, how to determine the most effective size of fan to use, and other phases of modern ventilation. Request this bulletin on your business letter head. *The Emerson Electric Mfg. Company, St. Louis, Missouri.—Gratis.*

Jessop New Process Cold Header Die Steel is an eight-page illustrated booklet describing a non-porous steel developed especially to meet the severe service conditions encountered when cold-heading bolts, screws, rivets, nails, buttons, and other small metal objects. Complete information on the heat treatment of this steel has been included. *Jessop Steel Company, Washington, Pennsylvania.—Gratis.*

Supplement To "Our Colorful World," Filmosound Library, brings total of titles under this head to 37 single reels, for the most part silent, dealing with various geographical regions. The list includes a series of five on National Parks, one on Indian life today, and one on Porto Rico. Another series of nine new reels deals with wild life, mostly birds, each reel covering either a single species or a habitat group. *Bell & Howell Company, 1801 Larchmont Ave., Chicago, Illinois.—Gratis.*

Speed Regulation and Control on Rural Highways, by Raymond G. Paustian, is an 88-page report of a special investigation of measures used in various states in attempting to increase highway safety for both vehicles and pedestrians. Phases covered are speed studies, legislation, night speeds and visibility, speed zoning, law enforcement, speed-measuring equipment, and so on. *National Research Council, 2101 Constitution Avenue, Washington, D. C.—$1.*

Manual on Insulating Varnishes is a 34-page booklet designed to assist the industrial user in the proper selection and application of insulating varnishes. Included are descriptions of 31 insulating varnishes, paints, and enamels, giving characteristics, uses, applications, and types. *Irvington Varnish & Insulator Company, Irvington, New Jersey.—Gratis.*

Alemite Progressive Lubricating System for Industry is an eight-page illustrated pamphlet giving details on a centralized system which has been designed to permit "one-shot" high-pressure grease lubrication to a number of bearings on a given piece of industrial equipment. Any type of manually or power-operated grease gun can be used. *Alemite, 1826 Diversey Parkway, Chicago, Illinois.—Gratis.*

It Sands, Saws, Hones, Files is a four-page illustrated leaflet describing in some detail two models of reciprocating multi-purpose hand tools for use in either intermittent or continuous production operations in various types of machine work. Complete specifications and prices are given. *H & H Research Company, 1925 W. Buena Vista, Detroit, Michigan.—Gratis.*

Western Electric 6B Audiometer is a 14-page illustrated bulletin giving general details of this newest device for swift and sure diagnosis of hearing defects. The Audiometer is so simple in operation that a nurse or doctor's office assistant can readily become competent in its use. *Graybar Electric Company, 420 Lexington Avenue, New York, New York.—Gratis.*

Tips on Better Child Pictures, by Ruth Alexander Nichols, is a 12-page illustrated brochure giving succinct yet comprehensive information on child photography. Most of the data are concerned with how best to pose children; the last two pages deal with lighting and exposure meter work. Request publication GES-2730. *—General Electric Company, Schenectady, New York.—Gratis.*

Magnesium Fires and Incendiary Bombs is a folder describing a new type of dry fire-extinguishing powder of particular interest to defense industries. *Pyrene Manufacturing Company, Newark, New Jersey. —Gratis.*

The Change to Plastics is a folder giving 12 industrial case histories in which plastics have been used for making items formerly made of other materials. ***Plastics Department of the General Electric Company, Pittsfield, Massachusetts.—Gratis.***

"ABSENCE MAKES THE HEART GROW ________?"

Advertising Takes on Its Most Important Job In Building Public Good Will and Confidence

By H. A. BATTEN
President, N. W. Ayer & Son, Inc.

★

THE other day I attended the wedding of the happiest young fellow in the world. He had won a fine girl against tough competition, and his smile was almost big enough to turn upside down and use for a coat hanger. There was another young man attending the ceremony whose face would have worked in better at a funeral. I knew him, too, and he stopped me when we left the church.

"Harry," he mumbled, "I don't understand it. Wouldn't you have said, a few months ago, that Jack and I were pretty even as far as Mary was concerned?"

When I nodded, he went on, "I had to go away on a business trip, and Jack was away also. Mary liked us both just about the same when we left. But when we came back, she took him. What's the answer?"

"Of course you telephoned and wrote to her?" I asked.

"We-ell, Harry, you know I'm not much of a hand at that. . ."

American industry is going away on a business trip. It's the most important business of all: national defense. American industry won't be able to spend as much time as usual courting the public with products and services. In many cases, the needs of national defense will make it necessary for the public to get along with fewer products and services.

Let's make the parallel a little more definite. Company A goes away on the busines of national defense. It decides that it isn't much of a hand at writing back home to the public. Besides, Company A executives remind themselves, they told the public they loved it before they went away, and it's a shame to waste money by repetition. The public will be waiting faithfully after the emergency is over.

Of course the public won't be waiting . . . not if progressive Company B has, in the meantime, carried out its carefully-planned, sustained advertising program.

There are a lot of old sayings about what absence does to human emotions, and they happen to contradict each other. Distance lends enchantment. Absence makes the heart grow fonder. Out of sight, out of mind,

Perhaps the reason for these contradictions is that people sometimes think that absence and neglect are synonyms. Let's see how it sounds: Neglect makes the heart grow fonder. The answer is, of course, that absence makes the heart grow either fonder or colder, depending on the efforts made by the parties in question to overcome the barrier of physical separation.

The best representative a company can have with the public is a satisfactory product or service. When these products and services cannot be provided, this representation is lacking, and advertising must take over the increasingly important job of carrying on in its place.

At first glance, it might seem that the main job of advertising during the national defense emergency is to maintain the good will of the public toward a company, and its interest in the company's products and services, so that a profitable market will be insured when the emergency ends, defense contracts shrink, and supply again begins to approach civilian demands.

This is a big job, and every advertising program today should be planned with this purpose in view. But this is merely one of the responsibilities which advertising must assume. It is even one of the lesser responsibilities. A program planned for this purpose alone would be limited and static, whereas the times call for something much more dynamic.

One of the primary purposes of an advertising program today should be to create general public confidence in the future of this country. People are worried. One minute they hear that this country is all out for defense; the next minute, they hear that defense production is far below the mark, and that we cannot stand against totalitarian attacks no matter how great our efforts. France fell because a disillusioned, confused public had confidence in neither Frenchmen nor French institutions.

Advertising must build public morale by showing how the defense effort is progressing, and by demonstrating how industry is helping national defense through its productive facilities and its managerial experience. Obviously this will also create public confidence in the company carrying out such a program, and build up good will.

Business must explain to the public about changes in prices, and why certain products and services cannot be provided to meet unlimited demands from the consuming public.

It is not the responsibility of people in Washington to keep the public informed of these matters; it is the responsibility of business itself. Much of the confusion now existing in the mind of the public has been created by conflicting statements from Washington, in cases in which industries have ignored the responsibility of keeping the public informed as to facts.

Business has an opportunity now to tell the public about research, privately undertaken, to improve products and services. Business should keep people informed of long-range plans for meeting post-emergency problems of employment and of demands for goods and services.

One of the most important jobs of all is to hammer home the fact that our present gigantic defense effort was made possible because of the system of free enterprise developed in the United States. Various totalitarian nations began preparing for this war long ago. They concentrated production efforts on war material year after year. What these nations did in seven to twenty years, American industry has been asked to accomplish in two or three. And American industry is doing it!

This is a story which must be emphasized. The public has a right to know that the American system of free enterprise has made possible a defense effort without parallel in history. The public has an especial right to this knowledge in view of the fact that some people will undoubtedly use the emergency to further their agitation for state socialism, communism, fascism, and other un-American forms of government.

Business has a tremendous stake in the future, and it is the part of wisdom to guard that stake through the intelligent use of advertising—the most efficient and economical instrument which management has at is disposal. Many of our largest and most progressive businesses are already assigning jobs of this type to advertising, and it is reasonable to assume that many more will join the list as the emergency program continues. Advertising is being given its biggest job in history, and it has its greatest opportunity to prove its value to business and to the public.

OUR cover picture shows what the world looks like when you sit in the little seat beside the driver of a tank. The port in front of you is open, but when the tank goes into battle, the heavy piece of armor plate swings down, leaving only a slot for forward vision. What it feels like to ride in one of these modern juggernauts is described in the article beginning on page 183 of this issue.

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SCIENTIFIC AMERICAN

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NINETY-SEVENTH YEAR • ORSON D. MUNN, Editor

OCTOBER • 1941

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OUR POINT OF VIEW

NOW IS THE TIME TO INVENT

AT NO time in the course of industrial development is it more propitious to turn attention to the possibilities of invention than during periods of stress. At such times as the present, when the whole world is topsy-turvy and every nerve is being strained in the effort toward self-protection and self-preservation, the inventor—whether he dwell in the garret of romance or in the busy laboratories of industry—has available for his talents broad fields which, under more peaceful conditions, might be ignored.

Two-fold, indeed, is the reason why now, more than ever, is the time to invent. First, there is the immediate industrial and defense emergency to consider. Second, there is looming in the distance the troublous times of readjustment after World War II.

Entirely too well known to detail here are the limitations which national defense preparations have placed on industrial production for civilian purposes. Yet these very limitations are the factors which offer to inventors opportunities unparalleled in history. Scarcity of materials which have always been accepted in the past as irreplacable opens new vistas for the discovery and development of satisfactory substitutes and new or improved processes. Plastics, glass, wood products for metals; lacquers and other surface coatings for tin and chromium plating; new methods of treatment to make smaller quantities of materials do a better job: the list could go on and on to cover every aspect of the present emergency.

Add to this the need for inventions in the immediate field of national defense and the picture becomes even brighter for the inventor. Armor plate of improved resistance to shell fire or made from new and plentiful alloying metals; more powerful or more controllable explosives and detonators; greater mobility and maneuverability of anti-tank and other guns; improvements in aircraft of all descriptions; again the list could be extended almost indefinitely to include virtually every item used in warfare.

Then must be considered the crucial period of economic rearrangement after the war. Production for military purposes will, of course, be greatly curtailed, although it is to be hoped there will be no such idealistic agitation for complete disarmament as resulted in the emasculation of our national defense forces after World War I. With military production reduced there will be available ample facilities for civilian production, and those facilities must be used to the fullest if we are not to face another disastrous era of unemployment and depression. But, in order to utilize this post-war advantage to its maximum, our industries must be ready not only to resume operations where they were abandoned for defense purposes, but also to proceed under full steam in the production of new consumer goods of various types. And these new consumer goods can be made possible only through the ingenuity of those individuals who have had the foresight to realize that inventions conceived and developed now will stand the greatest chance of contributing materially to the prosperous times that will follow the war, if only the industrial and economic lessons of the 1920's are not forgotten.

Brief analysis will show that the two phases of inventive possibilities just outlined actually dovetail neatly. In exploring little known or virgin territory in the search for solutions to immediate problems, inventors all over the nation will be constantly uncovering new data in their respective fields of investigation, thus adding immeasurably to the sum total of technical and scientific knowledge. From this pool will be drawn those inventions, discoveries, processes, needed for purposes of military importance; this same pool will, in many cases, provide the fundamentals for development of the consumer goods mentioned previously. Add to this the fact that many war-time inventions of military significance have equal or greater value in peace-time applications, and it is readily seen that this period in the development of our nation holds greater promise than ever for the inventor.

The frontiers of chemistry, physics, mechanics, optics, all the sciences, are being rapidly expanded. There appears to be no limit to present-day inventive possibilities, other than the limits of the human brain. Surely, now, more than ever before, is the time to invent.—*A. P. P.*

DEAD?

"WHAT has become of evolution? You don't publish articles about it any more." Several readers have asked this question.

Some 15 years ago the subject was at white heat, and everybody expected it to remain so. Anti-evolutionists predicted that evolution would be banned everywhere, and scientists trembled for fear they were correct. Some seemed to think that laws would cut off all knowledge of the theory from coming generations, as might be done in Germany.

But nothing has happened. The dispute is practically dead. Science hasn't won, since science doesn't yet understand the method of evolution. The other side hasn't won either, though at their behest the word evolution is omitted from most textbooks for the young. Yet nobody today wants to argue. One can't even pick a good fight about it. There's something odd.

Certain tacit admissions on both sides seem to us to account best for the loss of scrappiness. Opponents evidently sense that they are fighting a retreating battle. On the other hand, we scientists, if candid, must admit that we haven't finally nailed down and riveted up proofs of evolution of the kind that convince opponents almost against their will. In moments when the more emotional, less intelligent, anti-evolutionary ranters desist, some of us realize this fact—such is human nature. Such an interval exists at present and it may be a good thing if both parties to the old fight keep it that way; it makes for more tolerance, open-mindedness.—*A. G. I.*

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of October, 1891)

ELEVATOR—"A passenger on one of the ferryboats leading to or from the upper portion of New York, or upon one of the numerous vessels passing up and down the Hudson, will notice on the Jersey shore, adjoining the West Shore Railroad station at Weehawken, a tall tower, communicating by a viaduct with the bluff, a few hundred feet distant. The tower is the passenger elevator of the North Hudson County Railway . . . The hydraulic elevator cylinders are 38 inches in diameter, and made in sections of 9 feet in length. The pistons of the hydraulic

cylinders are each provided with 2 steel rods 4¼ inches in diameter and 35 feet long. The pistons are geared by means of cables and sheaves in such a manner as to cause the car to move six feet for every foot of the travel of the piston."

YELLOW FEVER—"At a recent meeting of the Academy of Sciences, Paris, a paper was read on the preventive inoculations of yellow fever by M. Domingos Freire. The author has inoculated 10,881 persons with cultures of *Micrococcus amaril*. The mortality of those so vaccinated was 0.4 per cent, although the patients lived in districts infested with yellow fever, while the death rate of the uninoculated during the same period was from 30 to 40 per cent."

U. S., TOO—"The sun never sets on the soil of the United States. When it is 6 o'clock at Attoo Island, Alaska, it is 9:36 o'clock A. M. the next day on the eastern coast of Maine."

BLACK LIGHTING—"The report of the British Association Committee on Meteorological Photography, set forth, among other facts in relation to lighting: The so-called black flashes have been disposed of. The experiments described showed that the appearance is due to reversal produced by some form of diffused light having fallen upon the plate . . . After the flash had passed, the plate was left exposed for a few minutes, in the hope that a second flash might illuminate the same part of the sky. This happened, the lower part of the field of view being brightly lit up by a flash which was itself hidden in the clouds. Where the consequent glare crossed the undeveloped image of the flash, reversal has occurred, while no reversal can be detected in the other portion."

IT DIDN'T HAPPEN—"Use of electric roads for farms is destined, says the *Electrical Engineer,* to be enormous. At the present time the state of the vast majority of our rural highways is such as to render transportation a frightful tax upon production. But nothing is easier than to track and wire these roads, furnish them with motor trucks upon which the farm wagons can be run fully loaded, and then turn on the current at stated intervals from the power house in the nearest town or at the nearest water power . . . The bare possibility of getting promptly to market will stimulate the farmer to cultivate crops that now he dare not dream of. Moreover, the speed made will effect a most tremendous economy in the farmer's time . . . These electric roads will continue running through winter and spring months when ordinary dirt roads are utterly impassable."

RAIL SPEED—"Most experienced railroad men feel that the possibilities of steam practice are nearly reached, and that much greater speed is not practicable. A maximum of ninety miles an hour, with a running speed of sixty to seventy, is all that can be hoped for under the very best conditions . . . The maximum speed of which a locomotive is capable has not been materially increased in a number of years. The schedule time has been shortened, principally by improvements in detail and management which permit a higher speed on a more extended section of road because of greater safety and the greater degree of confidence inspired in the engine driver."

CHINESE LUCK—"The Chinese were very particular about lucky and unlucky colors. They liked Engish sewing needles, but would not buy many of them because they were wrapped up in black paper, black being an unlucky color. Another man developed a very good trade in printed Chinese calendars, and that trade continued good until he commenced printing his calendars on green paper, when his trade closed. He wondered why until he discovered that green was an unlucky color."

RUNAWAY STOPPER—"A successful trial of stopping a runaway team was witnessed by a large crowd on Michigan Avenue, Chicago, recently . . . By means of a small battery and coil in the carriage, a system of wiring through the harness, and the pressure of a conveniently located button, a mild shock is given the horses from the bit. The strange sensation induces them to back away from a seeming attack in front, and thereby causes them to immediately stop. The shock is not of sufficient strength to injure the animal in the least, but it is enough to check any horse."

RAIN MAKING—"The artificial production of rain is just now a topic of much interest. The government experiments carried on by Gen. Dyrenforth, at Midland, have not at all satisfied the public mind that rain can be produced on demand, but have aroused an interest which is intently waiting for further developments."

Photo by U. S. Army Signal Corps

MECHANIZED POWER ON THE MARCH

WHILE the terrific power and striking force of a modern armored division is best exemplified by its scores of tanks, these mechanized land "battle wagons" comprise but a small portion of the total number of vehicles necessary to transport and maintain such a division. No longer the slow, lumbering thing of crushing terror which accompanied advancing infantry in World War I, today's tank is a streamlined, fast-moving armored mechanism that forms the spearhead of modernized military offense and the bulwark of defense. To ride in one of these engines of destruction is to sense to the fullest their potential power, as related in the article beginning on the opposite page.

BOUNCE! — BUMP! — CLANK!

How It Feels to Ride in an Army Tank

A. D. RATHBONE, IV

YOU'RE in a tank—a clattering, crashing, speeding tank—in the gunner's bucket-like seat alongside driver Sergeant O'Rourke. You're dressed in fatigue clothes, your legs are stretched tensely out in front of you, your goggled eyes are bugging out of their sockets as you stare fixedly at the maze of pine trees and underbrush coming toward you at 25 miles an hour. A swirl of sand and dust cyclones up from under the thrashing Caterpillar tracks. It gets in your nose, your ears, and sharp particles of silica sting your cheeks. Those trees! They're closer every second. How will you get through them? Not even a 30-ton tank can knock 'em all over!

However, you've reckoned without Sergeant O'Rourke's driving ability. Crushing a growth of underbrush flat, the tank skims between two husky pines, whirls sharply left to avoid a third, then spins on its axis to the right. You're in the forest—you still don't know how you made it—and you smash ruthlessly on, flattening shrubs and small bushes, dodging, weaving, spinning like a big but fleet fullback running a broken field, avoiding heavy opposition and straight-arming the rest.

Suddenly there's a tree dead ahead. It's a man-sized tree, big enough to put an accordion pleat in the front end of any automobile —and this mechanized hullabaloo is heading straight for it! Involuntarily your lips open to shout a warning, but you get a mouthful of grit, and anyway O'Rourke couldn't hear you above the pandemonium. Like any well-regulated back-seat driver, you try to jam your feet through the steel floor plates, your whole body stiffens, and as the horrific crash becomes imminent, you close your eyes, duck your head, and hang on convulsively.

But there isn't any crash; not even a noticeable jar. A small shower of leaves and dead twigs comes through the open port in front of the gunner's seat, scatters itself harmlessly over your lap, and, amazed, you look up. The tree is gone and the tank is still racketing through the woods. A glance sideways at the driver brings a grin from him that says as plainly as spoken words, "Yes, I know how you feel"—and you *do* feel exactly that way.

NATIONAL DEFENSE

• Through courtesy of the United States Army, the writer of this article recently visited an Armored Division Camp. His personal experiences are described in these columns. •

Like some mechanical behemoth gone berserk, the tank plows savagely on, smashing sapplings like tooth-picks, turning underbrush into pulp as easily as you'd crush a tomato. Now and then a tree can't be avoided, so this monster of hubbub blandly smacks it flat, just as though it had never been there, but aside from an involuntary blink at the moment of contact, that doesn't bother you any more. You've had your first inoculation of armored division power and you've found it as exhilarating as a heady drug. Your puny little body of mere flesh and bones, scrooched down there in that gunner's seat, experiences a latent strength it has never before known and you feel that so long as you and Sergeant O'Rourke can keep that 30 tons of hell-let-loose under control, there's nothing you can't do.

A small clearing suddenly looms ahead and through it and into the woods on the other side winds one of those sandy, "snake-trail" roads. The sergeant wheels the tank into the trail and steps on the gas; the speedometer needle rises in tempo with the crescending clangor as all 25,000 parts of the tank are now strained for speed. You're doing 30, then 35; the needle hovers at the 40-mile mark; sand, dust, and the rich odor of hot, greasy metal assail your nostrils. While the sensation of speed in a tank is enhanced by the never-ending, ear-splitting racket, remember that you're doing 40 miles an hour in the belly of 30 tons—60,000 pounds —of steel, hurtling down a winding, twisting sand-trail—a demoniacal engine of destruction, if ever there was one.

AND now your imagination, needled with that sensation of tremendous power, begins to function, but it still has to work overtime to visualize what the entire tank brigade of an armored division would be like when on a punitive expedition against an enemy. Your recall there are five echelons to each division; command, reconnaissance, striking, support, and service. Command, or division headquarters, has sent out the reconnaissance battalion, consisting of two armored reconnaissance companies—the boys who ride the "peeps," "jeeps," and half-tracks —one light tank company, and one company of armored infantry, largely transported in half-track

Photo by U. S. Army Signal Corps

Banking on a sharp turn, a tank creates a miniature sandstorm

cars, to fan out ahead of the main striking force, locate the enemy, and radio back its information. In this they have been assisted by the radio-equipped observation planes that have scouted perhaps 150 miles in front and which have been protected by combat planes. Signal corps, responsible for the division's communications, including its more than 750 radios, has maintained excellent contact with the reconnaissance battalion. The ever-mobile division headquarters, armed with the desired data, has laid a plan of attack and you're in it.

You're part of the crew of just one of 108 medium tanks, assuming the brigade is striking in full force, and you're going into battle first to knock out enemy anti-tank guns and his strong points. Roaring and rattling along with you, sometimes ahead, sometimes behind—depending on the objectives—are 260 light tanks while, preliminary to the actual attack, and lifting as you advance, the motorized artillery regiment of the armored division has been laying down a barrage to cripple enemy defenses, prevent reinforcement, and disable his guns.

WELL up in the vanguard of this explosive thrust is the engineer battalion. It's their job to blow up anti-tank mines, to throw temporary bridges over the streams you'll come to, if you attain your objective, and to build road blocks, if necessary, to trap enemy mechanization. To perform these and a myriad of other jobs, the engineers lug along the tools of their trade on unbelievably powerful trucks and tractors. There are assault boats, utility power boats, and outboard motors; you'll find portable bridges and ferries, air compressors, portable cranes of tremendous lifting capacity; there'll be electric lighting sets, huge posthole diggers, and even a water-purification unit.

All these and many more are essential constituents of the armored division attack that your sorely tried imagination has striven to visualize as you rocketed down the snake-trail with the gleeful Sergeant O'Rourke in his bombilating tank. Suddenly that steel nightmare swerves from the trail, pulverizes a thicket, crashes through the woods for about 100 yards, and comes to an abrupt, pulse-quickening stop on the very verge of a deep, steep-sided ravine. "In the name of heaven!" you mentally mutter, "He isn't going down there?" and you glance apprehensively at the sergeant, but this time he doesn't look at you. He's studying the terrain, balancing the capabilities of his tank against nature's hazard.

Fortunately, there are many Sergeant O'Rourkes in our ever-growing armored divisions. They're all old army men who have been manipulating metal monsters since the Army first created a mechanized force in 1928, and, as today's instructors, when they finish grooming the newer and younger men, they will have infused them with an indefinable something that simultaneously radiates confident power and just the right amount of conservatism to utilize that power most efficiently. At least that's the impression you gain from Sergeant O'Rourke as you watch him maneuver his 30-ton ponderosity down into the ravine. At an angle that would appear impossible, you move slowly, clankingly down the hill; you splash through the tiny stream at the bottom and then, reversing the angle, you commence to climb. If that feeling of irresistible force was astounding during the earlier, smashing, crashing tactics on relatively level ground, it is overwhelming now, as the huge tank slowly but surely climbs up the steep incline. The engine emits a resonant roar as the Caterpillar tracks stubbornly and successfully fight off the law of gravity.

DESPITE the consumate faith that the tank's performance has generated, you heave a little sigh of relief as the machine teters gently forward over the brow of the ravine onto level ground. Once again you try to imagine 100 or 1000 tanks advancing against an enemy through country like this. Some, of course, will become disabled, by artillery fire or through mechanical difficulties. The latter may be minor, involving, for example, the mere replacement of a broken link in one of the tracks—an operation which, on a much larger scale, is comparable to replacing a drive-chain link back in boyhood bicycling days. If the trouble is serious, it's a job for the

Photo courtesy Chrysler Corporation

"Mechanized hullabaloo:" matchwood

service echelon. They'll be along soon, and with their enormous wreckers, tractors, cranes, winches, their mobile repair and machine shops, their motorized acetylene welding plants, there's little they can't salvage. Those fellows take a passionate delight in keeping every item of the armored division's rolling stock in first-class operating condition, and in doing it anywhere under all manner of conditions. As the commander of a service battalion said, "It's no good to us unless it's out of order."

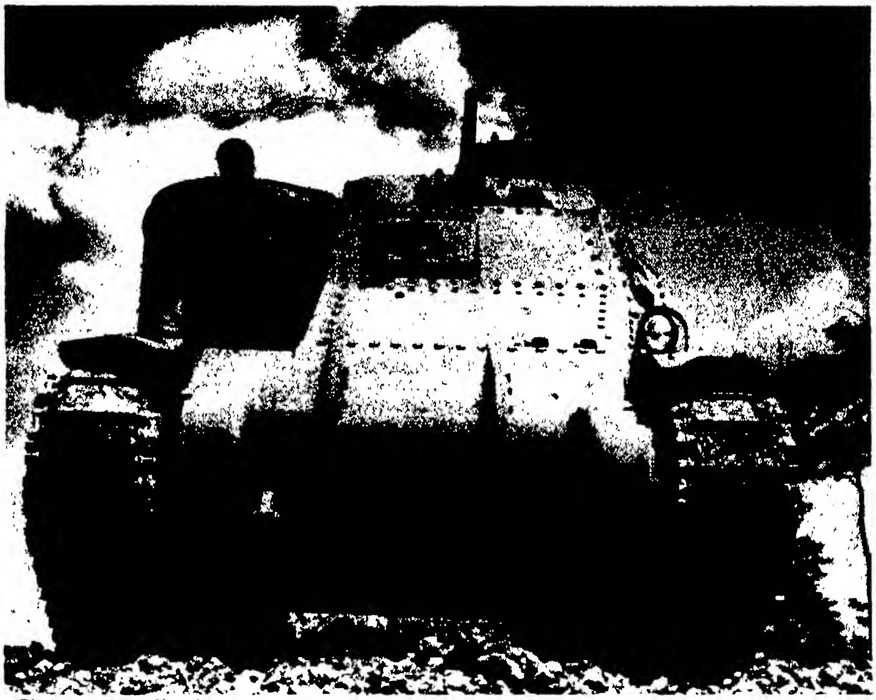

Photo courtesy Chrysler Corporation

A United States Army tank: brute force and heavy fire-power

BEFORE the service echelon arrives, however, the armored infantry regiment with its associated artillery battalion will have passed through in order to hold the ground won by the armored spear-thrust of the tanks and to repulse counter-attacks. Your ideal armored division infantryman is a tough, hard-bitten combination of dare-devil, mechanic, and expert marksman. He's imbued with that same spirit of unlimited power that hit you so forcefully after your first few minutes in the tank, but in his case he's been exposed to it ever since the beginning of his training. He has learned to shoot machine guns, "tommy-guns," pistols, Garand rifles, 37mm guns, and mortars. In numerous instances he's a "two-gun man," fighting with both pistol and machine gun, and although his training includes sufficient setting-up exercises, hikes, and overnight bivouacs to condition his body properly, his primary training has been toward shooting all manner of guns "on the run," in the mechanical mysteries of what makes an armored division click, and in communications of varying types.

Photo by U. S. Army Signal Corps

Under simulated aerial anti-tank fire

In this attack you've been envisioning, the infantry regiment will be following the spear-head thrust of your medium tanks and the light tanks in half-track cars, of which the division has over 500; in "bantams," or "peeps," which total 400; on many of the 400 solo motorcycles, and in various other conveyances, practically all of which mount guns of one sort or another. Two-way radio maintains constant contact with the mobile regimental headquarters, wherever it may be. One thing certain, the infantry will not depend on its feet to follow the fast and furious advance of your medium tank regiment that opened the gap in enemy lines, a gap that was widened by the light tanks just in the rear. The motorized infantry has accompanied or closely followed these lighter units; it has organized and is holding the vital points thus won, while you and the rest of the advance tanks, reinforced by heavily armored scout cars, are now darting in against the enemy flanks and against his rear.

In fact, if all phases of this theoretical maneuver have gone according to the time schedule, the entire operation has moved forward too rapidly for enemy counter-attacks to be effective against it. The flanks and rear of the spear-head have been guarded by the extreme speed and by the heavy, rapid fire-power of which an armored division is capable, rather than by formerly accepted methods which involved the sending out of flank and rear guard detachments and patrols. Your regiment of medium tanks and the rest of the vanguard have fanned out behind the enemy's pierced lines; you are playing havoc and raising hob with his communications, service lines, and any attempted reinforcements. Concurrently, perhaps, another armored division has duplicated your operations 100 miles or so from the point of your attack and ultimately, if all goes well, the fanned-out portions of the two divisions will complete a pincer movement, nipping off a large portion of enemy effectives and leaving a gaping hole in his defense.

THE past half hour's "practice spin" in a tank has vividly brought home to you the modus operandi of the armored force—a force calculated to operate independently against any kind of enemy under all imaginable conditions. You realize, too, that such vast and mobile power would be inestimably valuable in defense,

Photo by U. S. Army Signal Corps
Night practice maneuvers produce weird silhouettes

although you know full well that the American Army has not been one to take the defensive, and you can readily understand that fast and furious warfare of this type will tend to prevent conflicts from reaching an entrenched stalemate, as in 1917 and 1918. As Sergeant O'Rourke swings his metallic monster about and heads back toward the cantonment, you sense again and more fully that comforting feeling of latent strength. You're sort of a veteran now—in your own estimation—and you muse that if only you were 20 years younger, you'd like to join this man's army, this 20th Century version of Teddy Roosevelt's Rough Riders.

SUDDENLY, however, just as you're feeling a little over-confident in your ability to absorb the technique of life in a tank, you have the feeling that Sergeant O'Rourke has one more trick up his sleeve. The increased roar of the motor indicates a final spurt of speed down that gently rolling, sandy valley just ahead and the speedometer needle, at 35, at 40, at 45 confirms your suspicion that something is about to happen. That inquisitive side-glance at the sergeant begets nothing save a humorous quirk at the corner of his mouth and a mischievous twinkle in the crows' feet around his eyes. The sergeant is about to demonstrate something, but you can't figure out what it is.

The tank roars down the slope at a speed of nearly 50 miles an hour in the midst of a self-generated sand storm, and then you see what's ahead. There's an abrupt little rise of sand and a level surface beyond—a natural setting closely resembling the "jump-the-gap" constructions of circus days. You've seen it in pictures—a jeep, or maybe a tank completely off the ground as it tops a rise at high speed —and you've wondered how the men kept their teeth in when the machine jolted back to earth. Now you're going to find out.

There's a second of suspense as the tank catapults up the slope, a momentary racing of the motor as, front end still pointed skyward, this speeding mass of steel manages to leap free from solid traction. Before you can catch your breath there's a good, solid "ker-plunk!" You're back on terra firma, you haven't lost any teeth, the jolt wasn't nearly as bad as might be expected, and you're left with one, all-pervading impression —*power!*

Sergeant O'Rourke is appreciative of expressions of gratitude for the ride. He had a good time, too, but when you intimate it wasn't as rough-and-tumble a trip as you had anticipated, he grins and says, "I'd like to take you out in really tough country. You'd know you'd been in a tank!"—so perhaps it's just as well the initiation took place over gentle, rolling terrain.

Of course, tanks and scout cars are not new to our Army. The Cavalry has had a mechanized force since 1931, and the infantry has been experimenting with tanks since the World War, but our scheme for employment of tank units was based largely on British and French concepts, which made such forces subordinate parts of larger, usually infantry, organizations. The latter were not mechanized and could move only about one-tenth as fast. Opposed to this was the German idea of a large, smashing battle force—a complete armored unit of all needed arms—which could penetrate enemy lines and hold the gains thus made, independently of other support. The crushing success of Nazi *schnell truppen* in 1939-40 left no doubt as to which of these two theories was correct, and the United States Army began to reorganize its mechanized units accordingly.

As has been stated, the first mechanized force was created in 1928, but it remained relatively inactive until the winter of 1930, when General Summerall, then Chief of Staff, assembled it at Fort Wallace, Virginia. It was split up on November 1, 1931, between Fort Knox, Kentucky, and Fort George G. Meade, Maryland. An Infantry Tank School was established at the latter post, but moved to Fort Benning, Georgia, the following year. When the directive of July 10, 1940, created the present armored corps, it was decided to base the 1st Division at Fort Knox, the 2nd at Fort Benning, with the door wisely left wide open for expansion. Today, the 3rd Armored Division has been organized at Camp Polk, Louisiana, the 4th Armored Division at Pine Camp, New York, and the 5th Armored Division will shortly be activated at Fort Knox, Kentucky. Some 7500 men who have trained with the armored forces at Fort Knox and Fort Benning are providing the backbone of the manpower for the 3rd and 4th Divisions, and all four will join in providing personnel for the 5th Division. They are being augmented by recruits and men chosen for service under the Selective Service Act. The War Department will increase the numerical and mechanical strength of its armored force as rapidly as practicable. Informed sources estimate that the total personnel of the armored force will reach 80,000 during 1942.

SOME concept of the detail involved in organizing and maintaining an armored division may be gained by realization that the armored brigade, or main striking force of each division, contains 1350 vehicles in addition to 270 light and a little over 100 medium tanks. The brigade would require 30 miles of road space on the

march, allowing 40 yards between vehicles for freedom of movement. A fully complemented armored division would stretch out to 110 miles on the march—more than the highway distance from New York City to Philadelphia, Pennsylvania.

As to armament, including weapons mounted on vehicles, each armored division of 12,697 officers and men is equipped with some 400 37mm guns; over 100 75mm guns; 3600 .30-caliber light and heavy machine guns; 800 .50-caliber machine guns; 2000 .45-caliber submachine guns; 36 105mm howitzers; 21 60mm mortars; 20 81mm mortars; 10,000 .45-caliber pistols; 2000 Garand rifles; and a dozen .30-caliber automatic rifles. In addition to tanks, the following amazing diversity of vehicles is included: around 100 scout cars; 500 half-track cars; 20 mortar carriers; 145 personnel carriers; 20 motor ambulances; light passenger cars; 400 solo motorcycles; 400 "bantams"; 100 half-ton command trucks; 100 half-ton pick-up trucks; 9 half-ton weapon carriers; 650 two-and-one-half-ton cargo trucks; 120 two-and-one-half-ton cargo trucks with winches, and a supporting complement of tractors with angle dozers and trailers; artillery repair trucks; automotive repair trucks; emergency repair trucks; instrument repair trucks; machine shop trucks; small arms repair trucks; spare parts trucks; tank maintenance trucks; 10-ton wrecker trucks; tool and bench trucks; welding trucks; radio trucks; a panel delivery truck; two-and-one-half-ton wrecker trucks; four-ton cargo trucks; four-ton tractor trucks; four-ton wrecker trucks; gas and oil trucks; crane trucks, and, for good measure, a few other miscellaneous trucks.

Photo by U. S. Army Signal Corps
Crashing through the woods from camouflage to open terrain

In April of this year the first 30-ton tank rolled off the production line, eight months ahead of schedule. This M-3, or medium tank, is the largest American tank now in production. While reliable reports place the weight of Germany's largest tank at 90 tons, the firing power of the M-3 is considered to equal or to surpass that of tanks in action abroad.

It is equipped with a 75mm gun which hurls a missile 15,000 yards. Included in its armament are an anti-aircraft gun and three machine guns, and the seven crash-helmeted crewmen can increase the deadliness of the tank by firing automatic weapons through ports. Although complete and exact production figures for tanks are naturally not available, it is public knowledge that they are coming off several different production lines at a rapidly increased pace. Early in August, for example, one manufacturer announced the completion of the 1000th tank constructed by that organization. Moreover, authentic reports indicate that production of the astounding variety of other armored vehicles required by our new fighting arm is progressing favorably. Meanwhile, the personnel is receiving its intensive basic training, it is practicing with such units as are available, and it is preparing itself to utilize to the fullest extent what has been proved to be the greatest factor in the succes of this new type of striking force—a factor epitomized by the one word—POWER.

Photo by U. S. Army Signal Corps
Power enough to defy the law of gravity

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TANK HEADACHE

The design of a tank is evolved from compromises between conflicting military requirements. These are: armament, armor, mobility, weight, number of men in crew, and speed of production. To balance these and other factors, yet bring out a vehicle that most nearly fits all probable warfare situations, is the tank designer's headache.

On They Roll

Ball and Roller Bearings Have a Number of Properties of Importance to Industry

P. F. KORYCINSKI, M.E.*

THERE is historical evidence that the ancients knew that "nothing rolls like a ball" because they knew that heavy loads could be carried by riding them on balls. Because balls were seldom available, however, rollers were substituted and, in this manner, great stone slabs were transported from quarries to the ancient temples and tombs.

Ball bearings were first introduced into the United States from Germany by the bicycle manufacturers as recently as the end of the last century; roller bearings were developed in the United States at about the same time. Yet today these machine elements are of tremendous importance. Continuous progress in the metallurgy of steel, improved methods of precision manufacture, extensive research, and large-scale production are the factors which have contributed to their success and extensive use.

Though ball and roller bearings are commonly known as anti-friction bearings, they have other properties of equally great or even greater importance. One of their most valuable qualities is the high degree of reliability which attends their employment by the manufacturer in production and by the machine user in service.

It is unnecessary to stress the obvious importance of bearings to the successful operation of any machine or equipment; only too frequently failure of this element serves to emphasize the fact and to jeopardize the success of an otherwise well-considered design. Unfortunately, the performance of a bearing in service is not entirely dependent on those conditions which can be analyzed in design. The design can anticipate load and speed conditions of normal operations or of heavy duty, but contingencies of operation play an almost equally important part and these involve many exceptional and unusual conditions as well as the hazard peculiar to the human element. It is not possible, however, to provide against every condition of abuse and neglect which may arise, although the owner or operator of the equipment will be quick to recognize the superiority of the machine which shows added stamina and reliability in meeting the demands he places upon it.

Precision is another property of great importance. Ball and roller bearings are manufactured to very close tolerances on both external and internal dimensions. The races and balls are ground to exceedingly close limits; the balls in standard bearings may be held within .000025 of an inch for sphericity and size.

Leading manufacturers also supply super-precision bearings for special purposes, the accuracy of which is even greater than that of standard. Thus the balls of the Fafnir super-precision bearings are selected to limits of five millionths (.000005) of an inch for size. The assembled bearing is checked for eccentricity to five decimal places. Each bearing is matched against another so carefully as to reduce variations between bearings to six decimal places.

Such super-precision ball bearings are not only very accurate, but also are pre-loaded. Pre-loading is the term applied to the rigidity that is attained by loading the bearings at assembly by forcing the faces of the bearing rings in or out of flushness. Thus additional loads from cutting tools, grinding wheels, and so on, result in extremely small deflections which, with the most precise measuring instruments, can be measured only in millionths. With such extreme precision a person can place his thumbnail against the spindle of a grinder turning at 60,000 r.p.m. and not feel motion.

ANOTHER important property of anti-friction bearings is that, in general, they require very little lubrication. Excessive lubrication, especially with oil, is not desirable, as such a condition promotes heated bearings and friction torque is increased. Theoretically, ball bearings can function without lubrication in the sense that plain bearings need lubrication, but oil or grease is applied for the following reasons: (a) to provide lubrication for the balls as they roll in the retainer pockets, (b) to dissipate the heat of metal deformation, (c) to prevent rusting or corrosion of the bearing surfaces, and (d) to protect the surfaces from water, acid, or any other foreign sub-

A bearing may weigh as much as four tons, yet inspection is delicate

*Original article by Mr. Korycinski appeared in the *Georgia Tech Engineer*. To this has been added, by the editorial staff of Scientific American, supplementary material.—*The Editor.*

stance. Grease, also, is very effective in sealing the housings.

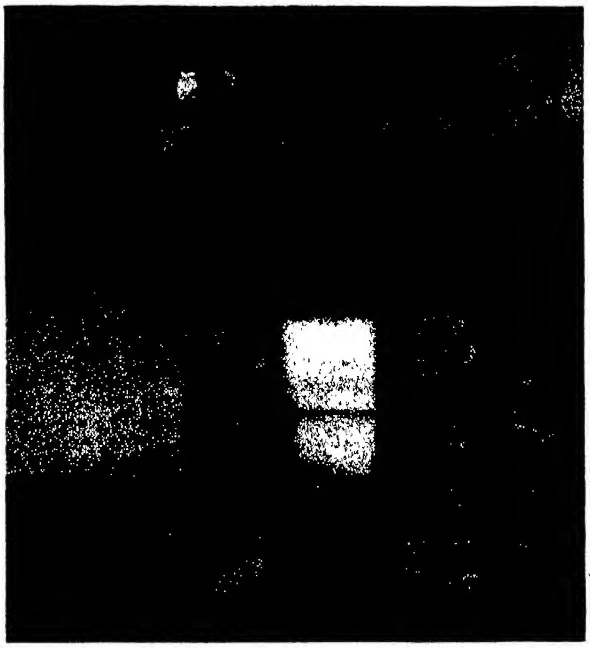
In selecting bearings the designer is generally concerned with the load-carrying capacity of the bearing. The manufacturers have listed in their catalogs data relative to the application of bearings in design. These data have been founded on scientific investigations first made by Hertz and Stribeck, of Germany. Although the basis for the data compiled by the manufacturers is the same, the load-carrying capacities of the same type of ball bearing made by two different manufacturers can vary. The reason for this variation is that the manufacturers use different life-ratings. Therefore, the manufacturer who bases the load-capacity of his bearing upon a short bearing life can have a high load-capacity. The following formula, as given by the SKF Industries, shows the relationship between the life of a bearing and speed and load:

$$\text{Hours life} = \frac{C}{(\text{speed}) \times (\text{load})^3}$$

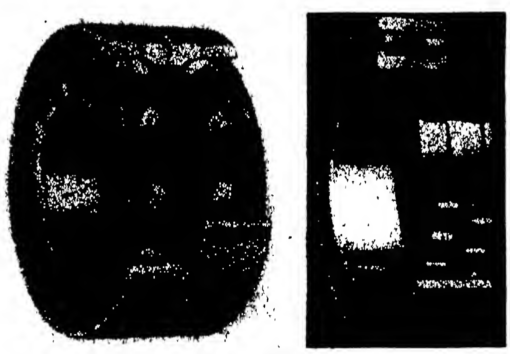
where C is a constant dependent on the type and size of the bearing. From the formula, it may be observed that when the speed is doubled the life is reduced to one-half; and when the load is doubled the life is reduced to one-eighth.

IN REGARD to friction, the SKF Industries assert that the low frictional characteristics of ball and roller bearings have been over-emphasized in the past, to the actual detriment of some of their most useful and valuable properties. This has been particularly true in the matter of power savings where the mistake has frequently been made of neglecting to consider other factors, aside from bearing friction, which are generally of equal importance. The possibility of saving power by the use of anti-friction bearings depends upon the relative efficiencies of this type and the plain bearing, as well as the percentage of the total power input which is absorbed by bearing friction.

Usually where conditions are such that high power-losses are present in the plain type of bearing, the principal advantage to be obtained from ball and roller bearings is the improved service from a maintenance point of view rather than spectacular savings in the realm of power consumption alone.



An example of heavy-duty bearing use; Tapered roller bearings in a steel rolling mill



Two types: *Left*, a super-precision ball bearing and, *right*, a double-row SKF bearing of the cylindrical roller type

There is no extremely great superiority from a standpoint of low operating friction of ball and roller bearings over the plain bearings, provided the latter are perfectly lubricated and in good shape. In fact, for the higher loads, the coefficient of friction for the roller and plain bearings is practically the same. For ball bearings the coefficient of friction is lower and remains fairly constant under different loads and speeds.

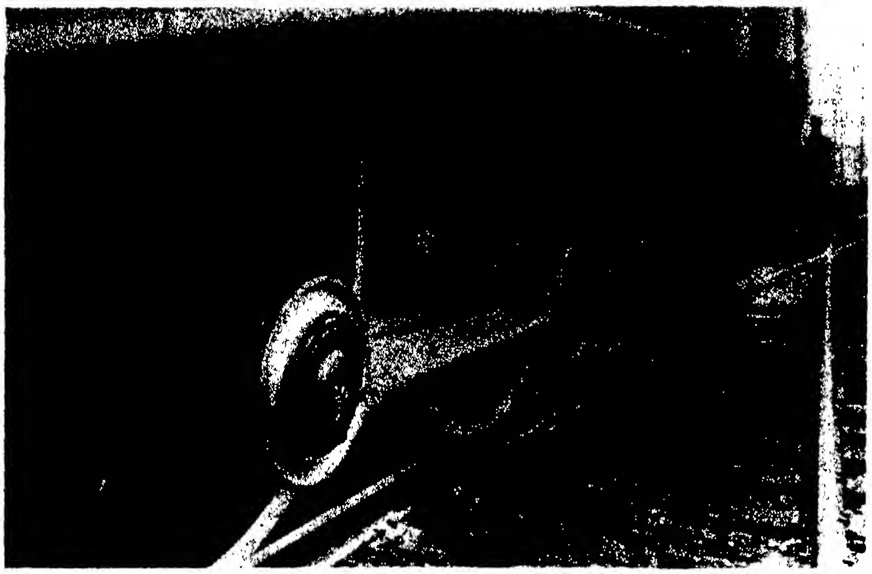
In considering starting friction, however, the plain bearing has a relatively high coefficient of friction, whereas the ball and roller bearings have practically the same friction at starting as when running. This is a valuable property where starting torque is an important consideration, as in railway service.

The possibilities of the ball or sphere as a rolling, load-carrying member were appreciated very early in the development of the anti-friction bearing. Owing to its simple shape, it was a comparatively easy matter to produce balls of high accuracy. The problem of turning out accurate rollers at competitive cost is more involved but today it is possible to make rollers which compare favorably with the best balls.

WITH roller bearings, the difficulty encountered was the tendency for the cylindrical rollers to skew or misalign. In a few revolutions of a moderate size bearing, the rollers would travel the equivalent of only a foot or so. But at several thousand r.p.m., the rollers would be required to travel approximately a fifth of a mile each minute. Any means to prevent the skewing tendency of the rollers in this distance requires a certain amount of force and means additional metal-to-metal sliding friction and wear. For this reason, roller bearings are used for high-speed work only when their design is such (cylindrical rollers, for example) as to reduce skewing to a minimum with low frictional losses.

Cylindrical roller bearings do not take thrust or angular load. Whereas this is an advantage in many applications it explains why other types of bearings must be used on a shaft to fix it axially. Pre-loaded ball bearings, however, carry combined radial and thrust loads with yields which are small enough to justify exclusive use of them where the loads are low. This applies, for instance, to internal grinder spindles. For the same reason ball bearings are good enough for many other high-speed applications with low loads such as electric or compressed-air hand tools, and so on, running at speeds up to 75,000 r.p.m.

Since the anti-friction bearings with cylindrical rolling members do not resist thrust or angular loads, many types have been produced with rollers variously tap-



Cross-head and all crank pins are equipped with Timken roller bearings

ered, thereby enabling them to resist thrust in one direction, in addition to radial loads. Upon this principle the Timken roller bearing was built. The Timken Roller Bearing Company asserts that true rolling motion is assured by making all lines coincident with the tapered surfaces of the rollers, cup and cone meeting at a common apex. This basic principle has been applied for more than 40 years by The Timken Roller Bearing Company and, judging from the number of Timken roller bearings in service, it is evidently a satisfactory principle.

Each type of bearing, roller and ball, has its limitations. The ball bearing generally carries light loads at high speeds. The roller bearing, on the other hand, accomplishes the opposite of the ball bearing. Where heavy loads, both constant and shock, are found, the roller bearing is preferred. Its higher load-carrying capacity is attributed to its greater contact surface. In a ball bearing little more than point contact is attained, whereas in the roller bearing the load is theoretically distributed along the entire length of the roller.

The needle bearing is a type of roller bearing which has compactness as its main advantage. This feature has been made use of in late automotive design of steering gear, kingpins, transmissions, universal joints, and in magnetos. In many applications, needle bearings are replacing the common brass bushing.

The SKF Industries have designed a bearing which is a compromise between the ball and roller bearing. They call it the spherical roller bearing. This bearing has the inherent ability of self-alignment, thus permitting the utilization of its full capacity under high radial and also high thrust loads or extreme conditions of shock load. The barrel-shaped rollers are so designed that they will remain in permanent contact with the center flange, thus assuring positive roller guidance. This bearing is particularly suited for heavy duty applications.

The first spherical roller bearings to be used for railway journal boxes in the United States were mounted on six coaches in 1921. Another "first" for these SKF products was an installation in the engine trucks of a steam locomotive in 1927, the first in this country ever to be mounted on anti-friction bearings. An outstanding example is one locomotive with spherical roller bearings in the driver boxes put in service in 1931. Since then the engine has run over 1,700,000 miles without bearing replacement—a fact which goes a long way in explaining why railways have found spherical roller bearings an effective aid in meeting competition.

As early as 1926, the Chicago, Milwaukee, St. Paul & Pacific Railroad came out in the market for roller bearing equipment for passenger train cars of all types. The problem confronting the Milwaukee Road was this: they were obtaining new equipment, including Pullman cars, for two luxury trains and they felt certain that it would be necessary to increase the number of cars in the trains. The existing locomotives would not have sufficient power to handle these heavier trains at higher speeds. The lack of power was particularly evident when starting. To have provided new power to handle these trains would have meant the expenditure of several million dollars, whereas the road had sufficient locomotives if someway could be found to reduce the starting and running loads.

Prior to this the Milwaukee had placed an existing car in service with tapered roller bearings and had run dynamometer car tests. The results of these tests demonstrated to their satisfaction that the roller bearing would reduce starting resistance and running resistance to the extent required for their existing engines to handle the new trains.

The first cars were placed in service during the winter of 1926-27 and in the early spring the first complete train, "The Pioneer Limited," went into regular revenue service. By early summer of 1927 all of the new cars were completed and "The Olympian" went into service. These first cars now have more than two million miles to their credit.

The first Timken applications to steam locomotives were made to the engine truck or leading truck. However, the company was anxious to get some test installations on driving axles, but the big drawback was that it was considered at that time that the openings in the existing frames were not large enough to provide for a sufficiently large bearing, which meant that new frames would be required.

The Timken management in 1929 decided to build a new locomotive to be equipped on all axles with roller bearings and to be loaned to the railroads for trial operation with the following points in mind: It would save a lot of time that would be required in developing tests on a number of roads. It would demonstrate in a dramatic way their confidence in their product to do the job.

The Timken locomotive was loaned to 14 different railroads during the 18 months' test period, covering approximately 100,000 miles. There were a large number of other roads that wanted to try out the engine, but at the end of 18 months, it was felt that the Timken position had been proved. The locomotive was then sold to the Northern Pacific Railroad and

it still is in passenger service on this road. It now has around 1,000,000 miles of service and nearly all of the original bearings are still in use.

The advice received from the operating departments of the railroads was that the locomotive was one of the finest engines ever built. The tests indicated that roller bearings provide a means of developing a combination engine which would be capable of handling all freight service and, without making any change whatever, would handle any passenger schedule in the United States and do both jobs in an efficient manner.

From the test data obtained from the many railroads which used the Timken locomotive, the final results were as follows:

The starting friction was 5 percent of that of plain bearings. The reduction of friction in starting the locomotive weighing 711,000 pounds adds an equivalent amount of weight that can be started without jerking. This equivalent is five Pullman cars.

Free coasting was achieved; that is, closing the throttle did not result in the bunching of the train on the locomotive and consequent taking up of slack when the throttle was opened.

Notable reductions were observed in maintenance and consumption of lubricants, fuel, and water. The conservative figures for increased development of power and of locomotive availability were set at 10 percent and 50 percent respectively.

Furthermore, the use of this locomotive would permit increased speeds, a reduction in road maintenance, and the elimination of hot boxes. With roller bearings, the temperature rise was only 15 to 30 degrees, Fahrenheit. Trainmen have commented that it was on the Timken locomotive that they saw frost on the driver bearing housings for the first time.

Such conclusive evidence could no longer be overlooked by the railroads. Since 1930 the majority of the locomotives built have been equipped with anti-friction bearings.

The successful use of anti-friction bearings by the railroads is typical of their use in all industries. The wheels of industry roll faster on anti-friction bearings.

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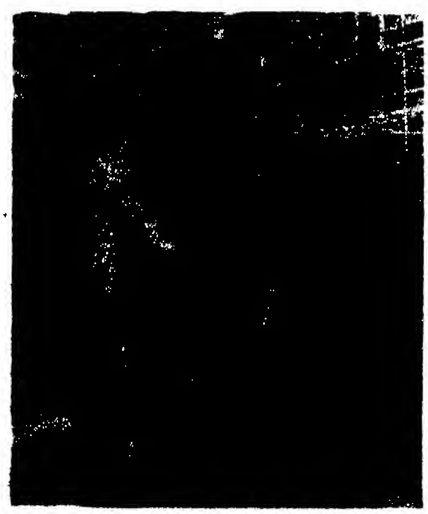
Stored Energy for Welding

High Current Flow for Short Time Period Particularly Adapted to Difficult Jobs

C. E. SMITH
Control Engineer, Westinghouse Electric and Manufacturing Co.

WITH the immediate emphasis on the production of airplanes and other defense implements, a new method of resistance welding assumes special significance. A recent development in resistance welding consists of first storing energy, either electro-statically or electro-magnetically, and then discharging it through the two metal parts to be joined. Thus it differs from conventional resistance-welding methods in which alternating-current energy is taken directly from the supply line while the weld is being made. It is particularly suited to welding metals of high thermal conductivity such as aluminum, because extremely high currents are required for very short periods of time if the weld is to be completely formed before the heat can be conducted away from the joint.



Welding with stored energy

One form of electro-magnetic stored-energy method of welding is shown schematically in Figure 1. It consists of a three-phase power supply, an ignitron welding

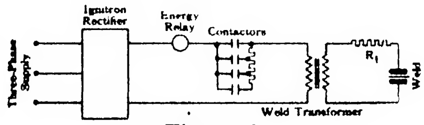


Figure 1

rectifier, a welding transformer, the welding machine, the main direct-current contactor, and suitable control relays. When the welding operator places the metals between the electrodes and pushes the foot switch, the electrodes are brought into contact with the work and the circuit through the welding transformer is automatically closed. The ignitron rectifier impresses a direct-current voltage across the transformer primary and the current rises exponentially at a rate determined by resistance and inductance of the transformer, which is the equivalent of an inductance with resistance in series. In this manner a charge of energy is stored in the iron core of the transformer for later release as welding energy.

Since any change of current in the primary of a transformer induces a current in the secondary, a current flows through the work even during charging and serves to preheat the work. At a preset primary current a current relay causes the contactor to start opening. As the contacts open, one after the other in sequence, more resistance is inserted until finally the last contact opens and ruptures the remaining primary current. The

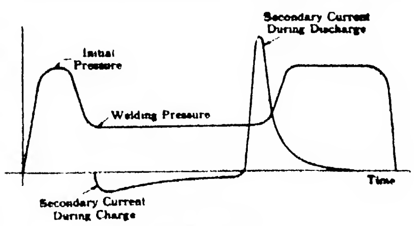


Figure 2

opening of the contactor causes a rapid reduction of primary current. The rapid change of flux in the iron caused by quick interruption of primary current generates a heavy surge of welding current in the secondary winding and the weld is made. This welding current then decays exponentially to zero as the energy is used up in the weld and in resistance.

The weld is made in a manner that differs from the usual resistance-welding technique in which the work is simply held under pressure between the electrodes during the current flow. With the stored-energy method, pressure on the joined parts is varied during welding operation. As shown in Figure 2, when the material to be welded is placed between the electrodes

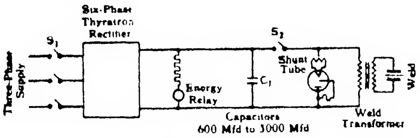


Figure 3

the welding machine applies to them a full pressure provided by an air-operated piston behind the upper or moving electrode. This action forces the two metal parts into intimate contact. After this application of initial contact pressure, the electrode pressure is decreased slightly. At the start of this period of pressure retraction the ignitron begins to charge the transformer. During this charging period the small preheating current flows in the secondary. When the maximum-current relay deenergizes the main contactor, the secondary current flows. During the fall or decay of secondary current, electrode pressure is suddenly increased. The final compression takes place as the heating period is near completion and after the material has fused. This action causes a mechanical working of the metal, which compensates changes in grain structure of the fused material caused by the heat during fusion. This application of pressure and its variation during welding is controlled by two separate magnetic valves through the action of electro-static time-delay relays.

THE electro-magnetic stored-energy system of welding, like conventional spot-welding schemes, makes use of ignitron tubes, although in a different way. Ordinarily ignitrons are used not as rectifiers but as power switches for a timer, advantage being taken of their timing ability to measure out the required number of cycles of alternating current allowed to flow into the "spot." On the new system, the ignitron is used as a rectifier, but there is no essential difference between the two ignitrons; the only difference is in their control. The rectifier is three-phase half-wave, using three single-anode ignitron tubes and three firing tubes for control of the ignitrons.

Inasmuch as the maximum charging time is approximately one second and since the bulk of a welder operator's time is taken with handling the work, it is economical to operate two welding machines from one rectifier. By electrical interlocking, only one welding machine can be loaded on the rectifier at a given instant.

The electro-static stored-energy system is shown in Figure 3. Here the power supply consists of a high-voltage multi-phase rectifier of 50 or 60 kva. With the closing of S_1, the capacitor bank, C_1, is charged to a high preset voltage. Then by means of an electronic energy relay the capacitor energy is discharged into the welding transformer. Adequate energy must be supplied in short time to make a good weld and the welding current must decay rapidly to prevent arcing as the electrodes separate. For these reasons an aperiodic secondary current has been found best.

AN advantage of either the electro-magnetic or electro-static stored-energy principle of welding is that energy is drawn from the supply lines slowly and discharged quickly. The instantaneous demand is reduced to approximately one-tenth that required by an equivalent alternating-current spot welder and the power-factor is increased almost to unity. Also, the load is balanced on the three-phase system, instead of being a peak single-phase load. As a comparison, the instantaneous power demand of an alternating-current spot-welding machine while welding two pieces of 0.080 aluminum is approximately 200 kva at 30 percent power-factor, single phase. The stored-energy method requires from 40 to 50 kva, on a three-phase balanced line at 100 to 90 percent power-factor.

A further advantage of the stored-energy system is that normal line-voltage variations do not alter the welding energy because the current relay does not release energy into the weld until the energy storage level established by the preset control has been reached. .

Unlike mild steel, aluminum and many other metals and alloys have a sharp fusion points; hence a narrow range of current, pressure, and time within which quality welds can be made. The stored-energy system thus broadens the field of resistance-welding controls by providing a new method of welding non-ferrous metals and alloys that are normally considered difficult to weld.

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BACK TO BESSEMER

Increased Versatility Paints A New Picture

THE invention of the Bessemer process in 1856 provided the cheap steel needed for rails and machinery in the great expansion after the American Civil War. Later it was largely superseded by the open-hearth process; but, today, steel men again are taking increased advantage of the speed and low equipment requirements of the Bessemer process.

The distinctive feature of the Bessemer process is a blast of cold air blown through the bottom of a pear-shaped vessel holding a molten pig-iron charge of as much as 35 tons. The air removes by oxidation the carbon, manganese, silicon, and other elements present as pig-iron impurities. The open-hearth charge contains some 150 tons of metal as scrap, pig iron, and iron ore. These, together with fluxing materials, are melted in a long, shallow hearth and the impurities oxidized by oxygen from the ore and from the furnace gases playing over the charge. In both Bessemer and open-hearth processes the oxidized impurities (except carbon dioxide, a gas) are removed in the slag.

Compared with the open-hearth process, the Bessemer has been a speedy but self-willed prima donna. The Bessemer air blast accomplishes in minutes the pig-iron purification which takes hours by simple reactions of the constituents of the open-hearth charge. However, the Bessemer process requires a liquid charge, with attendant supply difficulties; can use little scrap (not over 15 percent at the most); and has in the past been unable to remove phosphorus and sulfur from the pig iron. As commonly practiced in the United States, the Bessemer converter's refractory lining is acid in character and the slag must therefore also be acid and cannot absorb phosphorus present in the pig iron.

Since the phosphorus must be excluded from the finished steel, only low-phosphorus, "Bessemer" ores can be used. While the United States has a fair supply of such ores, the non-Bessemer grade predominates.

The basic open-hearth process can operate with liquid or solid charges, and generally uses large amounts of scrap, the percentage depending on the relative price of scrap and pig iron and usually averaging about 60 percent of the charge. It removes practically all the phosphorus from the charge into the slag, which is basic in character, and retains it, so that pig iron from high-phosphorus ore can be worked. Also it is possible to make a far greater range of steels than by the Bessemer process, including all of the ordinary alloy steels. However, the Bessemer plant and equipment are less expensive to erect and maintain and the process is simple in principle and in execution. With the Bessemer converter, the average time per heat is about 18 minutes for a charge of 25 tons, compared with 10 to 11 hours for a 150-ton open-hearth charge. The steel usually made is of the low-carbon grade and quite suitable for ordinary grades of wire and wire products such as fencing and nails, for some sheet products, for welded pipe, and excellent for screw machine products where free machining is essential.

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COMMUNICATION: The American railroads use 1,285,898 miles of telephone and telegraph wires in their operations. This would be sufficient to reach more than 51 times around the globe at the equator.

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A method has been worked out recently for observing the spectacular flame characteristic of the Bessemer process and thus regulating temperature and determining the exact time to turn down the vessel and end the operation. The end of the blow is the critical period; a few seconds' under- or over-blowing may cause non-uniform quality and actually harm the steel. By means of photo-electric cells, proper filters and amplification, more accurate control is possible, thus facilitating correlation of results with operating conditions and permitting later improvement in operating details.

If the sulfur in the orginal pig iron is too high for Bessemer use, the charge can be pre-treated in a ladle and much of the sulfur removed. This procedure was developed recently in iron foundries where the iron is treated with soda ash and sulfur removed in the basic slag produced. One plant using a two-ton converter to make steel for castings so treats its pig iron and produces finished steel castings comparable in sulfur content with many open-hearth products, and with consequently improved physical properties.

A STRIKING new method produces low-phosphorus Bessemer steel by after-treatment of the blown Bessemer metal in the ladle before pouring into ingots. A mixture of carefully burned lime, roll scale or iron ore, and fluorspar is added to the stream of liquid metal entering the ladle from the converter or vessel. A slag is produced which removes and retains much of the phosphorus. The acid Bessemer slag must be held back in the vessel or converter and must not enter the ladle, which requires careful attention to the analysis of the pig iron and to the method of blowing so as to produce a lumpy, viscous vessel slag that can be easily held back. With existing Bessemer equipment one steel company has thus made over 400,000 tons. This steel is of the usual low-carbon grades, but changes in equipment should make possible other grades, comparable with many that are now made in the open-hearth process.

In line with the increased versatility of the process, attention is being paid to converter size and design. Capacity per heat could apparently be increased at least to 50 tons and perhaps more. Improvements in blowing equipment and vessel-handling machinery are also being considered.

In 1939 about 3.5 million tons of Bessemer steel were made out of a total of about 53 million tons. This year 15 million out of a total of about 80 to 85 millions seems probable and another 10 million tons, compared with 2.25 million in 1939, will be blown in Bessemer converters for the tonnage possibilities and then transferred to open-hearth furnaces for finishing. Altogether a new picture is apparent in this revival of a spectacular old process.—*Industrial Bulletin* of Arthur D. Little, Inc.

FURNACES

Fans Give Uniform Operating Temperatures

FURNACE parts of stainless steel are helping many foundry-men to beat contract schedules for heat-treating jobs — particularly those that require close temperature control on a 24-hour-a-day operating basis. These stainless-steel parts generally include the convection fans, the interior linings, and the racks used in holding the loads. Examples of such furnaces are those made by the Despatch Oven Company, in a range of types that can be heated by gas, oil, or electricity.

One of our illustrations shows a Despatch furnace designed for handling aluminum castings, in which the interior temperature uniformity is held to within five

Withdrawing load from an aluminum heat-treating furnace

degrees, Fahrenheit, plus or minus, over an operating range which has 1000 degrees, Fahrenheit, as a maximum. This uniformity of temperature is accomplished by the use of oversized fan equipment which is mounted on the top of the furnace and circulates the air at a rate exceeding 20 miles per hour.

PLASTICS APPLICATIONS

A British Writer Offers Suggestions

It is no exaggeration to say that engineers are now becoming favorably impressed with the claims of plastics for applications where formerly metal was used exclusively. It is realized that for highly specialized purposes where metals suffer from certain inherent defects, plastics can often be relied upon to give a better performance. The classic and most impressive example is the use of laminated bearings for steel rolling mills instead of those formerly made of phosphor bronze. Experience over several years has now convinced many mill managements that the plastic bearing, although initially more expensive, is, in the long run, more economical. Not only is the plastic material able in many cases to insure a superior mechanical performance, but the actual time and labor saved in the fabrication of plastic parts can be considerable. An instance of this is the use of cams shaped of laminated board instead of steel for automatic screw machines. These new-type cams are now being made in less than one-sixth the time taken for steel. A set of three cams from laminated sheet blanks can be produced by means of a bandsaw and sander or file in 30 minutes, whereas three to four hours are necessary if steel is used. Moreover, these plastic cams are good for runs of 100,000 pieces or more, depending on the type of piece and the pressure.

In a time of national emergency, such as the present, the time and skill saved in machining by the use of plastic material can be quite appreciable, and the economy thus practiced may be reflected in an increased production of vital metal goods. The fact cannot be too widely known that plastics do offer solutions to several problems, and their extended use for applications which have so far been ignored would undoubtedly release labor and material.

The greatest need at the moment is for machine tools. A consideration of some of these should, therefore, prove of interest. Take, for instance, a modern engine lathe. At first sight this solidly built piece of high-precision engineering may not appear to offer very much opportunity for plastics, and yet there are several small ways in which these new raw materials could be incorporated in the design without interfering in any way with its efficiency. The actual casing of the lathe is normally made up of metal castings, which, in the main, must be very sturdy, strong, and rigid. The author stresses the qualifying remark "in the main," because certain parts of the casing are not normally subject to strain, and could be usefully made of formed laminated sheet or molded from high shock-resistant plastics. The end door for feed gear train, for instance, might be made of this laminated material, and its use for this purpose would not only save metal, but also reduce the total weight of the machine. Another part of the lathe which is not under strain is the oil sump, which is also made of cast metal. A good shock-resisting phenolic resin, preferably one reinforced with flock, would serve the purpose admirably and be well able to stand up to vibration and service wear and tear. Yet another application is the casing for the push-button station for the electric motor. Plastics are really ideal for this purpose as, quite apart from their avowed purpose of protecting the electrical parts, they are able to afford a high degree of insulation and thus help to prevent earthing. Various levers and wheels could also be molded of high-impact plastics without any reduction in efficiency.

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WEIGHT SAVING—In the manufacture of 10,490-pound freight car underframes, welded construction saves 1020 pounds of steel over riveted construction.

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Another type of machine tool now in great demand is the milling machine. This also offers opportunities for plastics. Casings for the starting boxes for drive and feed motors would be better molded of phenol-formaldehyde resin than made of metal stampings or pressings. The plastic casing would afford maximum protection to the switch-gear and also insure full protection from shock for the operator. Many other parts could be molded of suitable plastic material; for instance, the tool shelf, hand wheels, levels, speed plates, and so on. Another possible application for plastics in machine-tool construction is for extruded tubing of synthetic resins and rubbers for the cutting oil discharge and return lines now made of heavily armored rubber. Vinyl resins, neoprene, Thiokol, and so on, are virtually unaffected by oil, alkali, and water, and the extruded tubing can, therefore, be relied upon to stand up to service conditions.

Acrylic resin, such as Perspex, also offers some promise for oil gages normally made of glass. The former would be more robust than glass and be even more transparent. A suggestion was made some time ago by an American lighting engineer that special methyl methacrylate lighting devices might be constructed for use on machine tools, which would possess the major advantages of even, non-glare, and shadowless light and cold lighting, as distinct from the usual heat-producing methods of illumination. This is an advantage, as the normal system of lighting can cause considerable discomfort to operators during summer weather or in badly ventilated workshops, especially during a black-out.

The above suggestions, although apparently only referring to two types of machine, can be applied generally to many other types such as bandsaws, pantographs, cup grinders, and so on. The point the author would like to stress is that plastics are available possessing good mechanical properties, which, although not as good as steel, are sufficient for non-stressed or only moderately stressed parts. Undoubtedly, for at least half a dozen minor applications a plastic material is available which is well qualified to give satisfaction. The question might well be asked: what advantages can be gained by this policy of substitution? These can, perhaps, be best summarized as follows: Saving in metal, which may be quite appreciable; saving in time and labor; lower shipping weight; self-insulation of electrical parts.—*Haydn K. Wood, in* Plastics *(London).*

INDUSTRIAL TRENDS

AIRCRAFT PRODUCTION TOMORROW

Any attempt to trace industrial trends today must always be tempered by one unpredictable factor: the outcome of World War II. Also, every industry in the United States has felt the effect of national defense and of all-out aid to Britain and her allies. In some cases this effect has been relatively minor; in others it has changed the whole course of large industries and hence will have a definite bearing on future operations. In no case has the change been more spectacular than in the aircraft industry.

In any event, assuming always that the result of the war is such that free enterprise in one form or another still exists in at least a few countries of this troubled planet, aircraft manufacturers who are now rapidly expanding their production facilities can look forward to three general post-war markets for their products. First, in point of plant equipment and possibly even in dollar volume, will be military requirements for replacement in a continuance of adequate national defense. Second will be the demands of commercial transportation units for the expansion of passenger, express, and freight traffic that is bound to come. Third will be the private plane market, an outlet for planes that, slow as it has been in developing, is now showing signs of some day reaching proportions, for business and pleasure, somewhat comparable with that of the automobile market.

Just how large will be the demands for military planes after the war will depend mainly upon the unpredictable factor mentioned before. It is relatively safe to assume, however, that the lessons of the past will be applied to the future and that the United States will continue to pursue a policy of national defense as the best assurance of keeping out of trouble. In this event, basing a forecast on the assumption that our defenses will have been built to par before that so-far mythical period of "after the war," one of the jobs of the aircraft industry will be to keep our air forces supplied with replacements and with new types as they are developed and required. In this connection it is interesting to note that one naval authority has stated that, under routine peacetime maneuvers and operations, about 5 percent of all planes are put out of service annually through retirement and crackups. An Army Air Corps official estimates that the life of a pursuit plane is approximately two years and not over four. From these statements can be drawn a fairly adequate idea of military requirements of the future, using as a basis the highly publicized 50,000 planes that have been placed as our national defense goal.

The same factor of replacements that operates in the military aviation field also applies to commercial air transportation; because of the limitations that have been recently placed on the airlines, transport plane replacements immediately after the present emergency will undoubtedly put heavy, if temporary, demands on production facilities. Add to this the fact that air transportation for passengers and many express and freight items is rapidly gaining in popularity and the picture does not look too bad for the plane manufacturers. Although the Civil Aeronautics Board, at the moment, does not appear to favor the establishment of new airlines, it is probable that there will be considerable expansion of routes, although this expansion may be slow in coming; there is ample room for increased service.

On this page in our June, 1941, number, was discussed the matter of private planes, of which 6000 were produced during 1940. Today, according to the Civil Aeronautics Administration, there are about 100,000 private pilots in the United States, most of them the result of the government's pilot training program. The Army and Navy together expect to turn out some 20,000 to 40,000 pilots annually for the next few years. A large percentage of these fliers will undoubtedly be in the market for small, safe planes to be used for business and pleasure. If the development progresses as it should, and landing facilities in keeping with requirements are provided, the private-plane field should go a long way toward making aircraft manufacturers happy in the future.

So far nothing has been said about foreign markets, and purposely so. Whichever way the cat of war jumps, there will be keen competition between manufacturers in the United States and in Europe. What kind of economic warfare will result will depend on who wins the war, and this page is no place for unfounded guesses. While foreign markets will be an integral part of the post-war airplane manufacturing situation, it appears to be best for the moment to confine a consideration of trends to possibilities and probabilities within our own nation.

Come what may, the picture of aircraft production after the present emergency has passed seems to work out something like this: Highly expanded facilities will have to be curtailed somewhat to meet the requirements of the moment, yet it does not appear that the curtailment will by any means spell disaster. Markets there will be aplenty, although there will be ample and spirited competition in them all. The net result should be a healthy industry in which consolidations and combines, such as have characterized the coming-of-age of automobile manufacturing, will be in a position to take advantage of the experience gained under emergency production conditions to face any necessary readjustment with a minimum of difficulty and a maximum of continued operation.

GLASS TAKES ITS PART

The fact that the glass industry requires no raw materials that are essential to national defense—as the phrase is applied to aluminum, steel, tin, chlorine, explosives, and so on—is enabling it to carry on an expansion program such as has never been seen before in its history. As a result of this lack of restraint on development work, research is being carried on apace in an effort to provide replacement items for those which have been curtailed in the name of Mars. Thus there is being produced a wide variety of glass containers for materials which heretofore were packaged in tin cans, and large quantities of metals are being released for military purposes. It can be depended upon that the industry will exert every effort to continue this trend toward increasing uses of glass.

—*The Editors*

Cataract

In Recent Research Medical Science is Hot on the Trail of the Causes of this Ill

BARCLAY MOON NEWMAN

CATARACT is loss of transparency of the crystalline lens of the eye brought about when almost insignificant pinpoints of milky white appear here and there in it. If the tiny areas of opacity spread, varying degrees of cataract result. Sometimes complete blindness is the final stage.

The precise nature of the change in the living tissue of the eye lens is unknown. Most ophthalmologists believe that the proteins are coagulated—with a loss of transparency similar to the phenomenon taking place when egg white is heated. Glass blowers are continually exposed to the infra-red, or heat, waves from their flames, and they develop one type of cataract, presumably caused by the coagulating effect of infra-red rays on the albumin and other proteins of the lens.

Interest in cataract has increased greatly, not alone because of the increasing proportion today of the elderly in our population, among whom there is always a certain incidence of so-called senile cataract (the most common form of cataract), but also because of new and important discoveries on experimental cataract — that is, cataract deliberately produced in laboratory animals by a diversity of methods, chiefly chemical, in the hope of solving the mystery of cataract in human beings. This rising interest has led to more careful examination and study of the lens of the eye in persons past 50 years of age, and ophthalmologists now tell us that they are surprised to note how many "opacities"—pinpoints and small spots of opaqueness—are to be found in our eyes. Most of these almost insignificant opacities appear not to spread, or to spread very slowly. Yet, in an important percentage of cases, the development of the mysterious chemical change goes on apace so that sometimes vision is seriously impaired after a very few years.

The new discoveries are noteworthy and inspiring; since, where knowledge of cataracts in general is being gained, important facts about the special types that occur in human beings must follow, and where underlying causes are discovered, treatments and cures usually can be devised.

Some practical applications of the findings already have been made. A chemical, dinitrophenol, once unwisely promoted for weight reducing, has been shown to cause cataracts in animals—and this experiment clearly explains the strange development of cataracts in some persons after taking that chemical. Of course, you now cannot buy this chemical—even hidden, as formerly, in a "reducing medicine"—though as recently as a year or so ago you could.

A normal rat fed galactose . . . .

Dr. Paul L. Day has reported the development of cataract in mice, rats, chicks, and monkeys whose diet does not have enough riboflavin, one of the vitamins (previously known as B_2 as well as G). Recent confirmation of this investigation has taught that, in all probability, human lens tissue is healthy only if a certain minimum of riboflavin is eaten. You get riboflavin in any balanced diet—milk, eggs, liver, contain more than enough. The medical application here is now limited—and merely extends to making sure that the undernourished patient eats enough protective food factors. It is not known whether or not certain cases of *senile* cataract could be prevented from developing further by supplying riboflavin in quantity; *senile* cataract is definitely not the outcome of vitamin deficiency, though the eye, as we are all aware, suffers directly or indirectly whenever any portion of the human chemical mechanism is deranged, as by faulty diet. Nevertheless, with regard to another vitamin, ascorbic acid (vitamin C), it has repeatedly been reported by investigators that in dinitrophenol cataract, and even in senile cataract, a quick and favorable response follows large doses of this vitamin. Satisfactory confirmation, however, for these encouraging reports has as yet not been forthcoming.

RABBITS and rats given naphthalene develop cataract with startling rapidity — within a few days. This information is of value to industrial medicine which has the duty of protecting workers who annually handle 100,000,000 pounds of naphthalene and who under certain circumstances may be exposed to unusual concentrations of vapor from this raw material derived from the coal tar industry. (Here, however, it must be emphasized that mothballs, though they are made of naphthalene, are in no way dangerous in the home —that is, unless we should settle down to a steady diet of them!)

Cataract can also be produced experimentally by removal of the parathyroids, the tiny glands in intimate contact with the thyroid at the base of the neck. The parathyroids are vital regulators of the use of calcium. Calcium deposits in the lens of the eye are characteristic of senile cataract, and abnormally increased concentration of calcium there is generally found in any type of cataract. Hence, one theory is that in cases of cataract the parathyroids have long been acting abnormally. Evidence in support of this theory is turned up in cases of under-activity of the parathyroids, of over-activity, and of surgical removal (as for tumor) of these glands—in human beings.

Still, there is nothing definite along this line except a new lead and new inspiration for additional research.

Removal of the pancreas, which produces insulin as well as digestive juices, renders the animal used in experimental research diabetic. Diabetics often suffer cataract. Because insulin is an indispensable agent in holding sugar to normal concentrations in the blood, one theory is that diabetics develop cataract because of long-continued high concentrations of blood sugar. Another theory is that the bodily use of fatty substances is primarily disturbed—fat use being connected with sugar use. Further, in diabetic and senile cataract, fatty deposits are found. But some authorities think that the fatty deposits in the lens can occur only after injury to the eye tissues caused by exposure to high blood sugar concentrations.

Along this avenue there appears to have been definite advance, brought about largely through the work of Dr. Helen Swift Mitchell, research professor in nutrition at the Massachusetts State College.

Dr. Mitchell has discovered the strange phenomenon of "carbohydrate cataract." By simple feeding methods she has been able to bring sugars to a high concentration in the blood of rats, and when this very high level of sugar is maintained through several weeks, within this brief time all stages of senile cataract of the human type, as well as human diabetic cataract, seem to run a hasty course. Here is a neat and conveniently swift reproduction of cataractous changes, many, if not all, of which are to be found in degenerating human eyes —though, of course, the *start* of human cataract must, as we have seen, in different instances have different causes than mere high concentration of blood sugar and sugar in the lens tissue.

Once the start has been made, cataractous changes of different types apparently follow much the same course. To think of senile cataract as the result of high blood sugar is to confuse the first or basic cause with the way in which a lens can degenerate. For illustration, there may be many causes of falls from a dangerous cliff, yet the course and the end result do not differ in different cases. Detailed knowledge of the probable phases of development of human cataract is being accumulated.

Unlike human beings, rats are not adapted by evolution to the assimilation of large quantities of the simple sugar known as galactose, a close relative of dextrose, which can be derived from milk sugar. Hence rats, as Dr. Mitchell was the first to discover, when fed diets containing a large proportion of galactose run a very high blood sugar content, and cataracts are the most striking outcome of the experiment. It was at first thought that the particular sugar, galactose, was the specific cause of the cataract, and some persons, knowing that human milk contains, in terms

. . . . soon develops cataracts

of dry weight, 50 to 55 percent of milk sugar, began in alarm to speculate: "Is it safe for babies to have mother's milk?" But cooler heads pointed out that babies are not rats, and are by natural evolution adapted to and require large quantities of milk sugar, more than any other species; that diabetics develop dextrose cataract through upset of carbohydrate metabolism; that rats can be given dextrose cataract by removal of the insulin-manufacturing pancreas, and that probably any sugar appropriately administered (as by repeated hypodermic injection) can be used to induce cataractous changes.

Sure enough, Drs. William J. Darby and Paul L. Day, of the University of Arkansas School of Medicine, have been able to use another simple sugar, xylose or "wood sugar," in causing high blood sugar concentrations and, afterward, cataract in rats. Now it is universally recognized that milk sugar and galactose have nothing to do with human cataracts, whereas disturbance of dextrose use in the diabetic has direct bearing on changes in the eye. Since it is impossible to devise a life-giving diet without the use of dextrose and galactose (or a dextrose-and-galactose-producing carbohydrate, such as starch or milk sugar), the excitement about the danger of feeding mother's milk to babies has subsided; milk sugar produces, during digestion, both glucose (dextrose) and galactose. Further, baby needs galactose for the development of major components of brain and nerve tissue, as well as for the production of vital molecules in every part of the body.

Research on the changes taking place in carbohydrate cataract in rats continues. One important finding is that in this type of cataract, too, there is a greatly increased quantity of calcium in the eye lens, and efforts are being made to determine the way in which this mineral element becomes thus concentrated in eye tissue though not in the blood of the same animal. Hence, studies on the permeability of the membranes of the lens to calcium passage in and out are under way. If means of preventing or even of reversing the migration of calcium can be devised, a major step in the treatment of senile cataract will be at hand.

Meanwhile, we already have an inspiring conclusion derived by a distinguished ophthalmologist, Dr. Arthur Yudkin, of New Haven, from his recent experience in applying the newer knowledge of nutrition to the treatment of many patients suffering eye degenerations through deficiency of vitamins A, C, and B complex: "There is little doubt that many elderly patients could be restored to an active, healthy, happy existence by giving attention to their diet." Eye changes, but not cataract, result from deficiencies of these vitamins; yet, where so much gain has been made in a few years, far more important advances, extending even to cataract, are to be logically expected. And as Dr. Yudkin reminds us, the eye is the most sensitive register of bodily health. Cataract can be but a symptom of deeper ill. When cataract is treated successfully, we can be sure that more serious disorders are being alleviated. Thus experimental cataracts have great import.

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PROSTATE

Treatment Gives Hope For Sufferers From Cancer of Prostate

Lives of thousands of men suffering from cancer may be saved by a new sex hormone treatment announced by Dr. Charles Huggins,

Dr. George Gomori, Dr. C. V. Hodges and Dr. W. W. Scott, of the University of Chicago.

The treatment brought spectacular benefit in 80 percent of cases of cancer of the prostate gland, which is one of the commonest and most hopeless types. The treatment is not a "cure," Dr. Huggins said, because it does not kill the cancer cells, but it stops the malignant activity of the cancer cells in the prostate gland and of those that have spread from there into the bones, and shrinks the size of the cancers. The 21 patients reported on were beyond hope of benefit from operation to remove the cancer when the new treatment was started two years ago, as are most patients with this type of cancer when first seen by physicians. Today, 17 of the 21 are alive, although they would ordinarily have been expected to live only half this long even with the aid of radium or X-ray treatments. Of the four who died, only one died of cancer, the others dying of apoplexy or heart disease.

The successfully treated patients have gained from 40 to 80 pounds each, their red blood cells have increased from an anemic 2,000,000 to a healthy 5,000,000, they are free of the pain which was so severe as to require constant morphine, they have hearty appetites, demanding "seconds" at every meal, instead of the cancer patient's typically poor appetite, and they have been able to get out of bed and go back to work.—*Science Service.*

RIDICULOUS?

Grandma Was Partly Right—She Didn't Know Why

Some of the old therapeutic customs that seemed ridiculous in the dawn of this scientific age have since been found to have basis in sound fact, *The Industrial Bulletin* of Arthur D. Little, Inc., states. The feeding of ashes of burned sponges to persons suffering from goiter is now recognized as effective, if a bit crude, because of the high content of iodine in the ash. The Chinese use of the skin of the head of a toad for staunching wounds seemed most revolting until a considerable content of adrenalin was demonstrated therein. Another old custom, the taking of sulfur and molasses as a spring tonic, now appears to have similar scientific justification. While the usefulness of the sulfur part of the combination remains to be proved, the molasses part has been found to provide dietary supplements needed particularly after the depletions of the winter.

Molasses has been found to be a rich source of iron and calcium, the minerals most commonly lacking in the American diet, and also of several vitamins of the B complex, which are associated in nature with plant carbohydrates. Unlike a number of other foods having a relatively high iron content, molasses has its iron mostly in a form readily assimilable by the human body.

Refined white sugar is a pure carbohydrate, more devoid of minerals and vitamins than any other food we eat, even more than white flour, which is currently attracting so much attention directed to enrichment with food factors lost in processing. Sugar forms more than two-thirds as large a part of the American diet as does flour. Since molasses is essentially a concentrate of the portions of the sugar cane juice lost in refining, its dietary value in foods and feed can be readily understood.

SWIMMERS

Anatomical Trick Useful in Protecting Sinuses

The trick of closing one's nostrils when diving into the water is not a completely lost human accomplishment, despite medical opinion, reports *Science Service.*

One of the leading physicists of the National Bureau of Standards, Dr. L. B. Tuckerman, has made known that in childhood he had recaptured this ability supposedly lost in the evolutionary process.

"Some of the boys who went swimming together when I was young heard about how hard it is to wiggle one's ears and make the muscle, *compressor narium,* close the nostrils," Dr. Tuckerman expained. "So we practiced faithfully until several of us could do both.

"I can still do both. When I dive today I always close my nostrils."

Doctors advise that water be kept out of the nose, ears, and sinuses, particularly if the swimmer has had sinus or ear trouble. Diving or underwater swimming forces water into these parts of the human anatomy, unless they are protected. Infections may thus be spread. Use of a nose clip is recommended for those who cannot close their nostrils naturally.

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ACCIDENTS: More persons between the ages of three and twenty-four years die as a result of accidents than as the result of any disease.

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SUPERSONICS

Antigens Extracted from Germs With Ultrasonic Waves

Squeezing and shaking substances valuable in medicine out of cultures of disease germs by means of intense sound waves is the biological feat that has been accomplished by two University of Pennsylvania scientists, Dr. Leslie A. Chambers and Dr. Earl W. Flosdorf, reports *Science Service.*

The substances they obtain belong to the class of antigens — poisons secreted within the germs' bodies. Injected into the human body in suitably small quantities, they may be used in provoking the formation, by our own tissues, of opposing antibodies, which defeat the germs, if they attack later on. Or the antigens may be injected into the bodies of animals, from which blood is later withdrawn for making serums.

Present methods of obtaining antigens involve heating, addition of chemicals, or other treatments that injure or destroy certain of the more sensitively composed antigens. This is what the new method of Drs. Chambers and Flosdorf is designed to avoid. Its treatment of the germs is strictly physical or mechanical, and it can be conducted at a low temperature.

The foundation of their apparatus is a magnetized metal tube, usually made of nickel, which is caused to vibrate extremely rapidly by an alternating electrical current flowing through coils surrounding it. The sound waves thus set up may be exceedingly shrill, or even in the ultrasonic range.

Over the upper end of the metal tube a glass tube is fitted, with a leak-tight rubber joint. Into the chamber thus formed is poured a culture fluid containing billions of germs. Then the current is turned on and the vibrations started.

Whence Came Oil?

Most Geologists Now Hold that Petroleum Was Derived from Plants and Animals

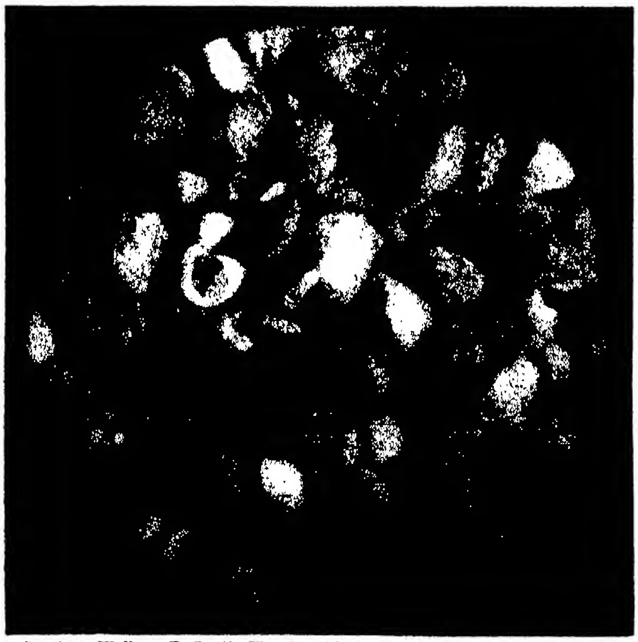
RANDALL WRIGHT
Petroleum Geologist

THE problem of the origin of oil is one of the most intriguing mysteries of science. Theories which have been offered to solve this question are as varied as they are curious and interesting.

Gasoline that drives your car as well as bomb-dropping airplanes is obtained from crude oil that comes up from the Earth's subsurface, through wells drilled to subterranean reservoirs. The working oil geologist is, of course, concerned mainly with the purely practical problem of finding where these reservoirs are now. Naturally, however, he also wonders how the oil was originally formed. If you ask him he usually will say, "We do not know," chiefly because as a scientist he is conservative and prefers to play safe. But he has some pretty good ideas about the various theories of the origin of petroleum, which he may discuss with you if you catch him at the right moment.

There is, for example, a theory that might, if you will permit the word, be called "atavistic" — the theory that petroleum was made at the time the Earth itself was formed. If the Earth was born out of the Sun, then it should be elementally similar to its parent—which it is. The chemical elements contained in oil exist in the Sun; the spectroscope has shown us that carbon and hydrogen are there. Also, a spectroscope at The Mount Wilson Observatory recently revealed that "heavenly hydrocarbons" — substances which are either oil or closely akin to it—do exist in the Sun's atmosphere. Then, too, we know that some of the meteorites which fall to earth contain asphalt, as though they had been in contact with oil some time in their past. If the Earth were formed of fragments which came out of the Sun, as most geologists agree actually happened, why is it not logical to suppose that oil might have arrived on earth ready-made?

This idea is intriguing, but it does not fit the facts that geologists have uncovered. For, if this scheme were true, oil could be found almost anywhere on Earth; whereas it is found in large quantities only in certain kind of rocks in certain special areas. These are the stratified rocks, and rocks of this type were formed, not mere periods but long eras after the Earth was born. The primordial earth-stuff was disintegrated by frost action and kindred processes into sand grains and mud particles, which then were carried by ancient rivers to the seas, there to be deposited and in time to become consolidated to make the sedimentary strata. In many of these sedimentary rocks there is no oil whatsoever, and thus it appears that we must abandon this imaginative theory as inapplicable to the conditions imposed by observation.



Courtesy Wallace E. Pratt, The Humble Oil and Refining Co.
Foraminifera, microscopic shells of marine growth, are frequently associated with petroleum deposits

At least as picturesque as the preceding hypothesis is the idea that oil was born in volcanoes. There is some striking evidence to support such a postulation. The lavas of Etna and Vesuvius contain oily substances. Further, the quicksilver ores of California, which are volcanic, contain a wax, Napalite, which might have been derived from petroleum. Also, oil in valuable amounts actually comes out of wells drilled in igneous, formerly molten, rocks in Mexico, Texas, California, and some other places.

THIS theory has had some ardent and capable supporters. For example, Mendeleëf, Russian chemist and author of the classification of chemical elements, was among the first to suggest that oil was formed in the processes of vulcanism.

Now these processes that occur deep within the Earth are complicated and manifold. Chiefly they involve tremendous heat and pressure, and it is true that under these conditions new substances form. Among these substances very probably are combinations of carbon with metals, such, for example, as the compound, calcium carbide, that, when touched by water, evolves acetylene gas for bicycle lamps or the primitive headlights of the horseless carriage days. Similarly, as the hot magma of a volcano works its way from the depths toward the surface of the Earth, carrying carbides, water may come in contact with it, evolving a hydrocarbon gas. In the laboratory such a gas has been synthesized into oil. Almost identical conditions arise in the volcanic environment. And, indeed, the petroleum-like substances found in the lavas and in the quicksilver ores very possibly were formed in this way.

So plausible is this theory that it carried much weight with the geologists of a couple of generations ago. They, however, lacked much of the information now available. As we now know, oil is found almost exclusively in sedimentary rocks. Those exceptions where oil in quantity is found in igneous

Courtesy Dr. Austin H. Clark, Smithsonian Institution

Conodonts, usually considered as the teeth of minute fossil fish; from black, oil-bearing shales of Carboniferous Period

rocks serve to prove the rule, since the oil in them has migrated from adjoining rocks which are sedimentary and contain oil. Further, the important oil fields are mostly distant from volcanoes. Conversely, in areas where there are only igneous rocks, no oil is found. Volcanoes may have made some oil, perhaps enough to form asphalt specimens as shown in the museums, but not much more.

The theory which is today believed to come close to the truth is that oil probably was formed in the strata deposited on the ancient sea bottoms. This idea is not so meteoric or so fiery as either of those sketched above, yet it contains more interest since it appears to involve life itself. This life is of the sort described in Beebe's "The Arcturus Adventure." Trawls were dropped from the ship to various depths and, when these nets were pulled back up to the ship, they were filled almost to bursting with living matter—microscopic plants and animals.

This same profusion of life existed in geologic eras gone by. For example, the tiny silica skeletons of the diatoms made deposits hundreds of feet thick, over thousands of square miles, in areas that now have been uplifted from the sea in Washington, California, Virginia, and some other places. If we can visualize such an enormous deposit of organic matter on the ancient sea bottom, we may be coming to understand the source of petroleum. In many places these layers of organic matter were covered with thousands of feet of sand and mud before the processes of decay could begin.

Some practical considerations strongly suggest that this idea is correct. For example, in areas from California to Russia these ancient events can be deciphered in the rocks. Moreover, the lack of oil in certain European countries has led to the mining of these organic rocks, or "oil shales," as in Scotland. These shales are slightly heated and compressed and the oil extracted.

This artificial extraction of petroleum from oil shale suggests that man is simulating Nature's laboratory. When the mountain-making movements of the Earth occur, the rocks are squeezed and probably gently heated. Then, or thereafter, it seems probable that some of the organic matter of the shale, for convenience called "carbo-gen," turns into oil and flows or migrates into the nearest porous formation, usually a sandstone. And, indeed, it is in sandstones situated close to oil shales that petroleum is most often found by drilling.

The immense quantity of tiny living matter known to exist today in the ocean is in line with the immense volume of petroleum already found. Moreover, this theory puts the milieu of formation of the oil close to that where it is now found by the drill. Also, these processes of pressing and gently heating the rocks were consistent through long stretches of geologic time, rather than evanescent like volcanoes, or primordial and cataclysmic like the birth of the Earth. Likewise, the nature of this theory suggests that much oil remains to be found.

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PETROSNOOPING

Vegetable Ashes May Help To Locate New Oil Fields

Burning vegetables to find oil is the newest exploration wrinkle advanced by petroleum scientists. The hypothesis, yet to be adequately proved, is based on the fact that certain plants tend to concentrate particular basic chemical elements in their tissues, when traces of these elements exist in the soil. If certain elements can be proved present in a specific underground geologic formation at one oil field, and if analysis of plant ashes in another location shows the same elements, chances are that the same geologic formation is buried under the spot where the plants grow.

Oil men for some years have been following particular geologic formations, that proved productive in one part of the country, for hundreds of miles in the hope that the formation that hid an oil sand in Texas, for example, will also have oil sands in Mississippi. Core drilling and micro-paleontology, relatively expensive, have been used in this type of oil exploration. Now plant-ash analysis may be a useful new tool for the same quest.

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BECOMING COMMONPLACE: There are now in operation throughout the world some 35 cyclotrons of varying sizes.

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GOLD

Its Recovery from Sea Water Advances

Commercial recovery of gold from seawater by electro-deposition has been brought one step nearer with the announcement by Prof. Colin G. Fink, of Columbia University, of a discovery which promises to make the electrochemical process more efficient. The discovery, which clarifies a hitherto baffling aspect of electrolysis, also provides a key to the electroplating of metals such as titanium and vanadium and should have far reaching commercial significance.

The ocean's gold content has been estimated at $25,000,000 per cubic mile, although gold is present in but a few parts per billion. While the metal has been extracted from seawater experimentally by an electrochemical method, the cost at best is five times the value of the gold recovered.

Usually in trying to electro-deposit gold from seawater, the metal precipitated out rapidly and failed to collect in crystalline form at the cathode—negative—electric terminal. This difficulty was overcome by substituting a high-speed rotating cathode for the stationary cathode. Then a distinctly visible deposit of gold was recovered on the cathode. But the cost of providing high-speed rotating cathodes makes the method commercially unfeasible.

Dr. Fink sought the reason for the disappearance of the gold when a stationary cathode was employed, and discovered for the first time that when gold passes out of or into solution two distinct steps are involved. Invisible gold in solution first goes into myriads

of infinitely small particles of colloidal gold, and only later into crystalline gold. The stationary cathode method failed to extract gold from seawater because the metal precipitated out in colloidal form and dropped away before becoming crystallized.

With the process understood, the remaining problem is to develop an inexpensive means of transforming the colloidal gold to crystalline form.

MUTATIONS

Atomic Particles Produce Hereditary Changes

STREAMS of neutrons, uncharged fragments of atoms smashed in the University of California cyclotron, have produced hereditary changes in living organisms, in experiments performed by Dr. Everett Ross Dempster.

As experimental material, Dr. Dempster used the familiar fruit fly, classic "guinea pig" of genetic research. He exposed male insects to the neutron stream, then mated them with untreated females and watched their offspring for mutations, or abrupt evolutionary changes. He found that neutrons are more effective than X-rays in producing certain types of mutations, less effective in producing others. —*Science Service.*

OUTDOORS INDOORS

Simulated Showers and Controlled Lightning Bolts

A LABORATORY that will bring the stormy outdoors indoors for study of the effects of rain and lightning on electrical equipment will be installed in Northwestern University's new $5,000,000 Technological Institute on the shore of Lake Michigan, it was recently announced.

Amid simulated showers, machine-made lighting will lash out in controlled bolts in the waterproofed laboratory to test the strength and lightning defenses of transformers and other apparatus that provide today's industry and homes with electric power.

The lightning-making equipment—a 1,500,000-volt surge generator and a 500,000 volt-ampere, 60-cycle, high voltage test set—will be built and installed by the Westinghouse Electric & Manufacturing Company. Westinghouse engineers collaborated with the Northwestern Technological Institute, headed by Dean O. W. Eshbach, in planning the laboratory. These high voltage installations will help make the engineering school at the Evanston, Illinois, university one of the best equipped in the United States.

The lightning laboratory will be used in the instruction of Northwestern students, for insulation research and commercial testing. It will be equipped to test insulation strength, transformers, insulators, circuit breakers, and other electrical apparatus. Only the section especially designed for the synthetic rain tests will be waterproofed.

Doors that will act as safety switches are among the elaborate protective devices to be installed in the laboratory for the safety of students or others who might enter the high voltage room. The doors will be so interlocked with the equipment that, should a person accidentally open one and wander into the room, the high voltage circuits would be immediately opened and rendered harmless.

Northwestern later will install a "power follow" transformer for testing lightning arresters under service conditions, and the university plans eventually to add a high-current surge generator to reproduce "hot" lightning — artificially made thunderbolts that have the burning current of natural lightning. Some artifically created thunderbolts lack this firing force, which causes natural lightning to ignite barns and other unprotected wooden structures.

VIABLE

Some Seeds Germinate After Sixty Years

SIXTY years is the survival time for seeds of curly dock, evening primrose, smooth mullein, and night-flowering catchfly in one of botany's classic experiments, reported by Prof. H. T. Darlington of Michigan State College, in the *American Journal of Botany.*

Sixty years ago a former professor of botany at the college, Dr. J. W. Beal, buried 20 pint bottles, each containing 1000 assorted weed seeds mixed in sand. The idea was to dig up one bottle every five years and find out how many seeds were still viable, and what species they represented.

This five-year schedule was kept up until 20 years ago, when it was decided to make the experiment last longer by digging up the bottles at ten-year intervals. Prof. Darlington has been carrying on the project since 1915.

Of the 20 species originally put away, only four germinated in this latest test. Even these four do not represent a perfectly smooth score, for it was thought that the mullein seeds originally put into the bottles were all of the ordinary woolly species. But the smooth mullein is what came up this time, and also ten years ago, though it had not appeared in any of the earlier plantings.

Two species that survived up to the fiftieth year, black mustard and water smartweed, failed to germinate this time. Species that lasted 40 years but were missing at the half-century mark included pigweed, ragweed, peppercress, plantain, and purslane.

There are still 11 bottles buried in the soil of the State College campus.—*Science Service.*

GAS POISONING

Unexplained Effect of X-rays on Carbon Monoxide

X-RAYS saved the lives of animals nearly dead from carbon monoxide poisoning, in experiments reported by Dr. John A. Cameron, of the University of Missouri.

Rats and monkeys were used in pairs. Each pair was exposed to carbon monoxide until near the death point. Then one of the animals was given a heavy dose of X rays on the underside of its body; the other was left untreated, as a control.

"In about half the cases the X-rayed animal was active and alert after about five minutes; the control dead," Dr. Cameron stated. "In the remaining trials the recovery time of the X-rayed animal was reduced to two thirds that of the control; often to one half or less."

Spectrographs of the blood of the animals showed that the carbon monoxide content was actually reduced after X ray treatment. How this was brought about, Dr. Cameron is not yet prepared to state.—*Science Service.*

Star Stuff

Finding Out With the Spectroscope What the Sun and the Other Stars are Made of

HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

THERE was a time when it was supposed to be beyond human power to find out what the Sun and stars were made of. We all know how the "hopeless" problem was suddenly solved by the discovery that each element present in the Sun's atmosphere absorbs its own characteristic spectral lines, which can be matched in the laboratory. The qualitative analysis of the Sun—or at least of its atmosphere—then became simple; quantitative analysis, as in the laboratory, is more difficult.

There are three steps in the process—to measure the strength of each line; to find out how many atoms are at work producing it; and to find the whole number of atoms of each element.

The first step—the measurement of the amount of light cut out of the spectrum by a line—has been made for hundreds of lines by several observers, while Minnaert's Atlas contains easily available material for thousands. If we could perform the second, and find how many atoms were at work in producing a line of given light-loss or "equivalent width," we might get around the third—provided that we could observe the whole spectrum from the extreme infra-red to the remote ultra-violet, by simply adding the numbers of atoms producing each line of a given element. Only a rather small part of this spectral range is available; and allowance for the unobservable lines is a problem.

Coming back to the second step, we may note that no answer would be possible if the atoms at work on a given line played exactly the same note—in other words absorbed and gave out light of *exactly* the same frequency. If they did, any number of them would produce a spectral line, perfectly black, but infinitesimally narrow, which even the most powerful spectroscopes could not reveal. It is because the atoms are more or less out of tune, so to speak, that some of them absorb in different places in the spectrum from others, and give rise to a line of finite and observable width.

There are two things that put them out of tune. First, the atoms in the heated gas are in motion, and the lines of those which are approaching us are shifted toward the violet, and vice versa, by the Doppler effect. Second, no atom can keep an absolutely exact pitch. Even isolated atoms, undisturbed by others, will run a little off—some one way, some the other—and if other atoms collide with them while they are performing, they get more out of tune.

When the laborious calculations are made, it is found that when few atoms are present in the absorbing layer, the first (Doppler) process predominates, and the equivalent width is proportional to the number of atoms at work. This is represented by the steeply inclined dashed line in the illustration. If this effect alone was at work, the width would soon increase more slowly, and this curve become almost flat, as illustrated by the dashed line at the right.

THE natural imperfection of tuning gets its work in later, and causes the curve to rise again, but more slowly (the width now being proportional to the square root of the number of active atoms). When the atoms are uninfluenced by collisions, we get a curve like *A* or *B* (depending on the temperature and so on). With increasing numbers of collisions, this process becomes more important, and curves like *C* or *D* result.

We do not know in advance how much the atoms in the Sun's atmosphere are disturbed by collisions, and so cannot calculate in advance the shape of the curve of growth for solar lines. But if we can find in any way the relative numbers of atoms which are at work on different lines (whose widths we can measure), we can plot the curve from observation.

In complicated spectra, such as that of iron, there are numbers of lines which are known to be absorbed by atoms in the same state (or in closely related states). The relative numbers of the atoms in such a state that are at work on one or another of its lines can be calculated by theory, or be observed by laboratory measures of the brightness of emission lines. Such measures demand great care to escape a number of instrumental difficulties. A good start has already been made for iron and titanium, but years of work remain before we know what we would like to know, and, with sufficient pains, can find out. The present theory is satisfactory for simple spectra indicating, for example, that just twice as many calcium atoms are at work on the K line as on its companion H, or on one of the two sodium lines compared with the other. But, for intricate spectra, an accurate theory would have to take account of many complications, and is not yet fully worked out. Average results for a large number of lines should give fairly trustworthy values.

AN INTERESTING determination of this curve, based on certain groups (multiplets) of iron lines, and made by ten Bruggencate and Houtgast, at Potsdam, is reported in a German astronomical journal, a few copies of which have reached this country. Observations at the Sun's center, and close to the limb, agree in showing that the curves run steeply, a little above *D* in the drawing. For iron atoms at the Sun's temperature, and undisturbed by collisions, the curve would run about midway between *B* and *C*. It follows that the atoms in the Sun's atmosphere must be very considerably disturbed by collisions with others. We shall return to this; but let us first follow out the main problem of our quantitative analysis.

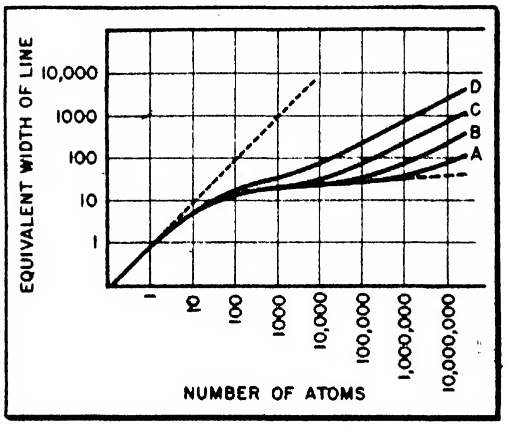
When a good curve of growth has been found, we can use it to determine how many atoms of a given element are at work in forming a particular line. The Doppler effect depends on the weight of the atoms and the temperature of the gas; but this can be allowed for. Collision,

in equal numbers, may have more influence on some atoms than on others, but this is a problem for the future. We can in any case get good values except for the strongest lines.

Problem number two is thus well advanced toward a solution. Suppose that it was fully cleared up, and that we could turn our lists of equivalent widths of lines into tables of numbers of atoms at work on each. We must now define more closely what we mean by "atoms at work." As we pointed out last month, the light which we receive from any given part of the Sun's disk is an average of contributions from different depths. Just as for the color or intensity of the light, there will be a certain average depth such that the number of atoms above it will account for the observed widths of the spectral lines. This depth may not be exactly the same for lines of different elements, and might be quite different for different regions of the spectrum, such as the red and ultra-violet. However, the observed change in color of the Sun's disk toward the edge shows that this effective depth does not change greatly, and so we need not worry much about this at present. More trouble arises from the fact that, in the ultra-violet, where the lines are strongest, they overlap one another so badly that it is difficult to interpret the complex mess.

Passing over this also, let us take our list of "active atoms" and proceed to add up all those of each element. For some, such as sodium and calcium, all the strongest lines are in the observable region, and our census of atoms should be nearly complete and give a good estimate of the actual population. We will get, of course, only the neutral atoms; the ionized atoms have entirely different spectra, which must be handled separately. For ionized sodium, all the lines are out of reach in the ultra-violet; but for calcium and for several other metals, we can get a good census for the ionized atoms, too. This enables us to calculate the degree to which other elements, also, must be ionized, and so allow for the ionized sodium atoms (which are more than a thousand times more numerous than the neutral atoms). Thus we extend our census, till we get pretty reliable counts for all the elements which have their strongest lines where we can get at them.

But some of the most interesting elements—carbon, nitrogen, and oxygen, for example—have only weak lines in the observable regions: that is, lines absorbed only by excited atoms which have been loaded up with a large amount of energy. We can find the numbers of these excited atoms pretty well. But the fraction of all the atoms in the excited state depends on the temperature of the gas, and the influence of the radiation which passes through it. These influences may be determined by comparing the number of atoms of iron, for example, in excited and unexcited states, which have already been found; but the extension of the calculation to the very highly excited states causes some uncertainty.



The curve of growth (see text)

The hardest thing of all to measure is the amount of hydrogen. The hydrogen lines are exceedingly strong, though they are absorbed by very highly excited atoms; and there can be no doubt that hydrogen is very abundant. But the hydrogen lines are peculiarly sensitive to all sorts of broadening influences—for example, to the electric fields of neighboring charged particles in the gas—and the amount of these influences cannot yet be accurately calculated.

The presence of large amounts of hydrogen has, however, various effects upon other features of the spectrum, from which its abundance can be estimated. For example, the hydrogen atoms in the Sun are practically all neutral and contribute none of the electrons which are responsible for the general opacity of the atmosphere. At higher temperatures, as the hydrogen atoms lose electrons, the atmosphere becomes very much more hazy. The depth in it from which the light gets out to us is greatly decreased, and the enhanced lines of the metals—which would otherwise be little affected by the rise in temperature—are greatly weakened. To produce so great an effect, the number of hydrogen atoms must be something like 1000 times that for all the metals together. In the cooler stars, compounds of hydrogen with metals, though rather easy to dissociate, show strongly in the spectra—another proof of the great abundance of hydrogen.

A third independent proof has just been provided. If the collisions which put the metallic atoms "out of tune" were with other similar atoms, there would be enough metal atoms to produce lines very much stronger than are observed.

Calculations by ten Bruggencate and Houtgast show that collisions with hydrogen atoms would produce just the observed effects, both at the Sun's center, where we see deep, and at the edge, where we observe only the outer layers, provided that the number of hydrogen atoms was 6000 times that of all the metals together. The older estimates were inevitably of no great numerical accuracy, and the later value is to be preferred.

Oxygen, nitrogen, and carbon would, in this calculation, be lumped with the hydrogen; but their lines are so much fainter that there can be no doubt that the Sun's outer layers are composed almost entirely of hydrogen, with what the chemist would call "traces" of other substances. There may be quite a bit of helium, but we have no way of estimating its amount in the Sun, for it produces no absorption lines, and the brightness of its emission lines (in the chromosphere) depends upon processes not yet amenable to numerical calculation.

For the hot star, Tau Scorpii, Unsöld has recently, by somewhat similar methods, found the composition (by numbers of atoms) hydrogen 10,000, helium 2000, carbon 1, nitrogen 3, oxygen 8, neon 3, while all the metals together add up about 1.

The relative abundance of the various metals appears to be decidedly similar in different stars, and much the same as on the Earth, but this story should wait until the results of new calculations—recently reported orally at Harvard—have been published.—*Jamestown, R. I., July 26, 1941.*

Curbing the Connecticut

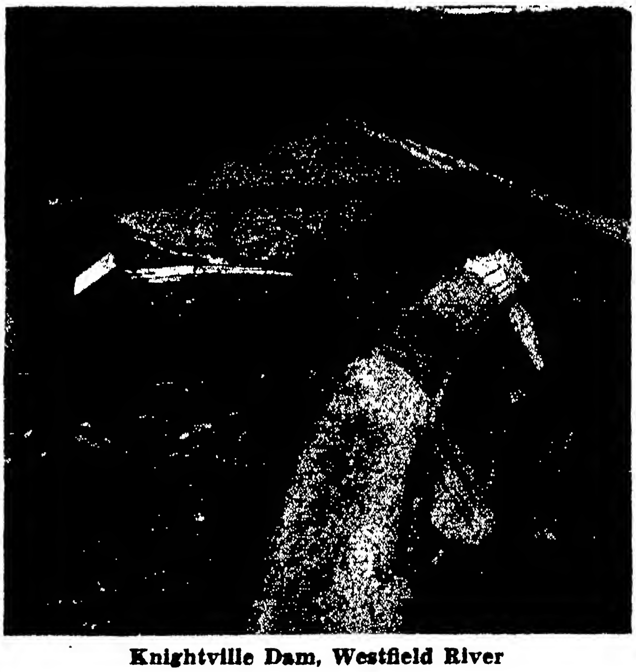
Control Measures Linked with Power Development, Water Conservation, and Recreation

FLOOD-CONTROL work now in progress on the Connecticut River is typical in most respects of similar work now in progress at many points throughout this country. For that reason the Connecticut River system has been chosen as illustrative of the manner in which the flood-control programs for our major river systems are being carried out.

Construction of ten reservoirs to reduce flood damage in the Connecticut River Valley was authorized in the Flood Control Act of 1936. No actual construction was begun in 1936 because Congress, after having authorized expenditure of $10,028,900 on the ten reservoirs, did not appropriate money for that purpose. Studies, however, were continued actively by the Army Engineers, so that by the time Congress came to draft the Flood Control Act of 1938 it had before it a tentative plan for comprehensive flood control on the Connecticut River. The plan called for the construction of 20 reservoirs and seven levee and flood wall projects.

The comprehensive flood-control plan is now being reviewed by the District Engineer, U. S. Engineer Department, at Providence, in the light of the flood of September, 1938. An interim report on the review was submitted to Congress last year, incorporating certain minor extensions to the levee program and a revised list of 20 reservoirs having a total capacity of 939,950 acre-feet and controlling 26 percent of the drainage area at Hartford. The total capacity of this new group of 20 reservoirs is 46 percent greater than the original plan. More recently the studies were completed and now are being examined by the Board of Engineers for Rivers and Harbors.

The Connecticut River has its source in northern New Hampshire, flows south forming the boundary between New Hampshire and Vermont, crosses the states of Massachusetts and Connecticut to discharge into Long Island Sound. It is 392 miles long and drains 11,260 square miles. The upper and western sections of the watershed are mountainous, the ruggedness decreasing as the coast is approached.



Knightville Dam, Westfield River

Floods have been frequent in the Connecticut River Valley and have produced a serious problem in the highly developed sections of the lower river and in the industrial towns that center around available power sites on the tributaries. The greatest flood of which there is record on the middle and lower river occurred in March, 1936, and caused direct damages estimated at $34,500,000. The flood of November, 1927, which, prior to the flood of September, 1938, was next in magnitude in recent years, was most destructive in the upper basin, notably in the White River watershed in Vermont. The direct damage amounted to $15,526,000. As a result of a heavy rain that preceded the hurricane of September, 1938, floods on the lower tributaries of the Connecticut exceeded all previous records, although the main river at Hartford was 2.2 feet below the 1936 record. The direct damage caused by the flood of 1938 amounted to $25,596,000. As a result of the 1938 flood, further changes in the flood control plan that had been submitted to Congress are now being studied.

Early in the studies of means for protecting communities in the Connecticut Valley from floods it was found that while complete protection to some of the communities in the lower valley could be provided by means of levees and flood walls, the main reliance in any scheme of protection would have to be placed on a combination of reservoirs and flood walls or levees. Further, it was found that complete protection could not be provided by means of reservoirs, because of the high cost of reservoirs of adequate capacity low enough on the tributaries to keep the flood flows on the tributaries and in the main river within safe limits. Main dependence had to be placed on comparatively small reservoirs located far enough up the tributaries to be above the settled regions of high land values.

FOR the design of levees and walls, a design flood was established by assuming an intense rainfall over the watershed and then translating this into run-off by the use of established methods. The discharge from each tributary was computed from the rainfall and the unit hydrograph of that particular stream, and the discharges from these several contributing areas were routed down the main river to produce the hydrograph at critical points in the lower basin. The rainfall assumed was about the same as for the storm of September, 1938, although differently distributed.

For the purpose of determining the economic justification for the projects under study, benefits were classified as those resulting from the elimination of recurring losses either directly or indirectly due to

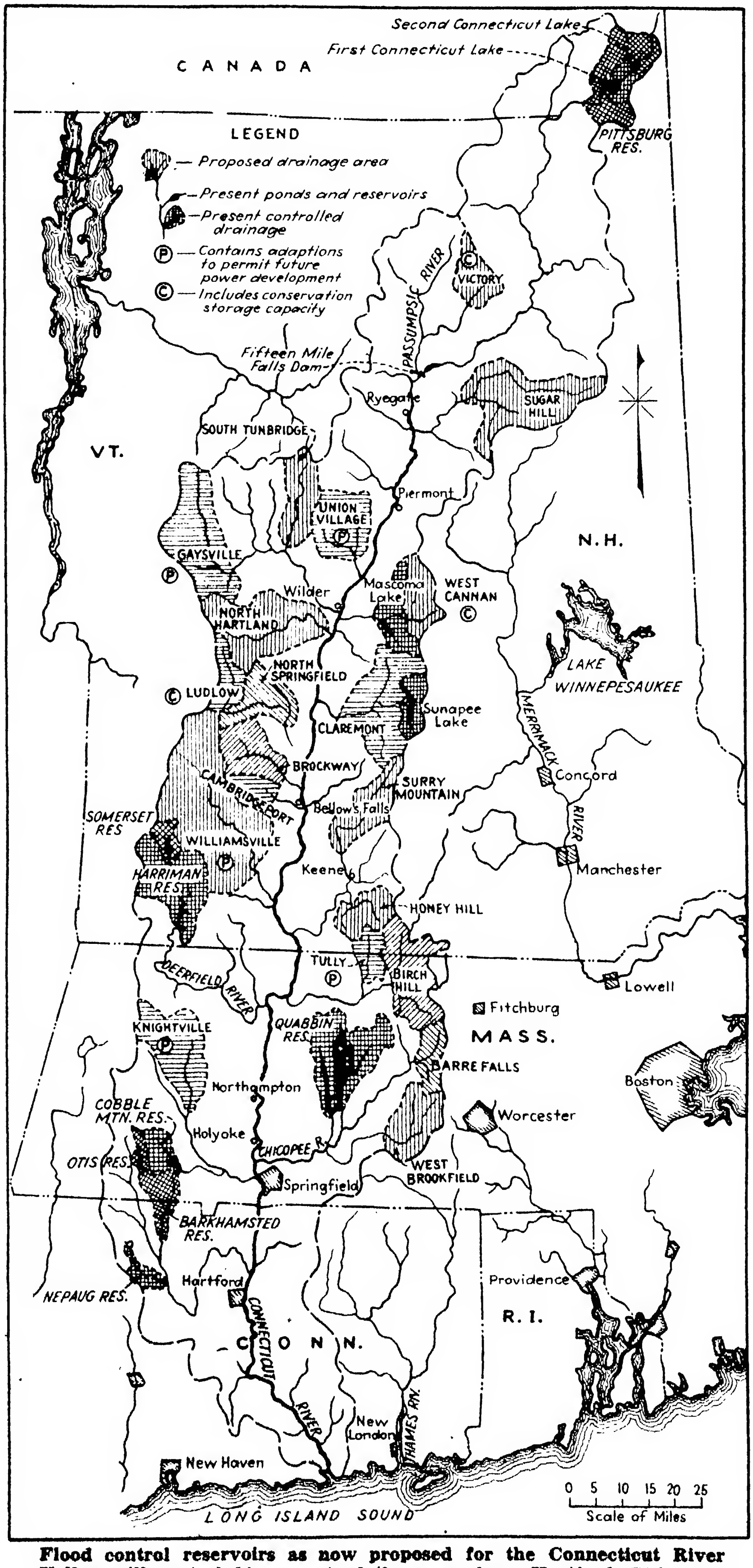
Text and illustrations courtesy *Engineering News-Record*.

flooding, and those resulting from the restoration of property values. Flood losses were appraised under three corresponding classifications. A careful determination of the direct and indirect losses resulting from the March, 1936, flood was made as soon as possible after the flood, for use in fixing preventable direct and indirect losses, which form the basis for direct and indirect benefits. Similarly, the actual or probable damage resulting from floods of lesser magnitude was determined, making it possible to place a value on the savings or benefits which result from each foot of reduction of the flood crest. Setting these figures over against flood-frequency curves, it was possible to put the probable direct and indirect benefits on an annual basis, thus giving a figure that could be compared with the annual cost for any reservoir or group of reservoirs.

The district engineer credited to the reservoir system all of the benefits which would accrue to it from reduction of direct and indirect damages, assuming that no levees would be constructed. He also credited to the reservoir system the benefits developed by the restoration of property values outside the area proposed for levee protection. To the levee system was given credit for the additional direct and indirect damages which it prevented, plus all benefits from the restoration of property values within the leveed area.

The reservoirs proposed in the interim report control 26 percent of the drainage area at Hartford. Existing water supply and power projects increase this control to about 32 percent. The system of 20 reservoirs will reduce flood heights at Springfield and Hartford by about five and six feet, respectively, in a flood of the magnitude of that of 1936.

The size of the individual reservoirs was selected to give the optimum ratio of flood protection benefits to annual charges. The locations of the reservoirs were selected to provide the most effective flood protection practical for the basin as a whole, due consideration being given to the sites available and the economics of the situation. Consideration was given to the relative economic values of the individual reservoirs; to the control of the amount of watershed area desired; and to the geographical distribution of reservoirs to ob-



Flood control reservoirs as now proposed for the Connecticut River Valley will control 26 percent of the area above Hartford. This map shows the drainage areas controlled by existing dams and dams under construction or proposed in an interim report submitted to Congress

tain dependable reduction of flood stages in the middle and lower reaches of the main river during storms of all probable types and magnitudes.

Spillways were designed for the worst possible conditions, it being assumed that each reservoir would be full to the spillway crest at the time its design flood occurred, even though the reservoirs are normally kept empty.

The costs of the comprehensive plan and the benefits to be derived from it were compared on an annual basis. Reservoir costs were computed at 3½ percent of the capital cost, plus a proper allowance for maintenance, operation, and amortization. The total benefits of the reservoir system proposed in the interim report exceed the total costs of the reservoirs. Similarly, the total benefits of the proposed levee protection exceed the total costs thereof. Extensive reservoir control is highly desirable, since it provides general benefits to the valley as a whole and will tend to increase in value with the normal development and expansion of communities in the valley. A reservoir system must be well distributed over the watershed in order to insure the realization of the benefits credited to the system as a whole, even in the event of a storm such as that of November, 1927, which centered over a limited portion of the watershed. This intangible "location" value may render an otherwise uneconomic reservoir desirable as one element of the total plan, in case of a storm centering above the reservoir. Levee protection is essential for low-lying congested communities along the main river in order to insure the complete protection which these highly developed communities require. Thus the combined system of reservoirs and levees will provide general protection for the valley as a whole and especial protection for those centers where damages have been concentrated as a result of past floods.

The most economical and easily improved sites for water-power development in the Connecticut basin have already been developed. The New England Power Association has had under consideration for some years the construction of a large hydro-electric plant at Upper Fifteen Mile Falls, a few miles above the existing plant located at Lower Fifteen Mile Falls.

The only possible water-power sites on the main river below the mouth of the Passumpsic River that have not been developed are at Piermont and Hart Island. Existing plants at Ryegate, Wilder, and Enfield do not have equipment of sufficient capacity to utilize additional flows, and until these plants are re-developed no appreciable benefits to them can be realized from future storage reservoirs. On some of the tributaries there are attractive natural sites for the development of new power stations, but on account of their comparatively small drainage areas and the wide variation in natural flows, these probably never will be developed unless conservation storage reservoirs are constructed above them.

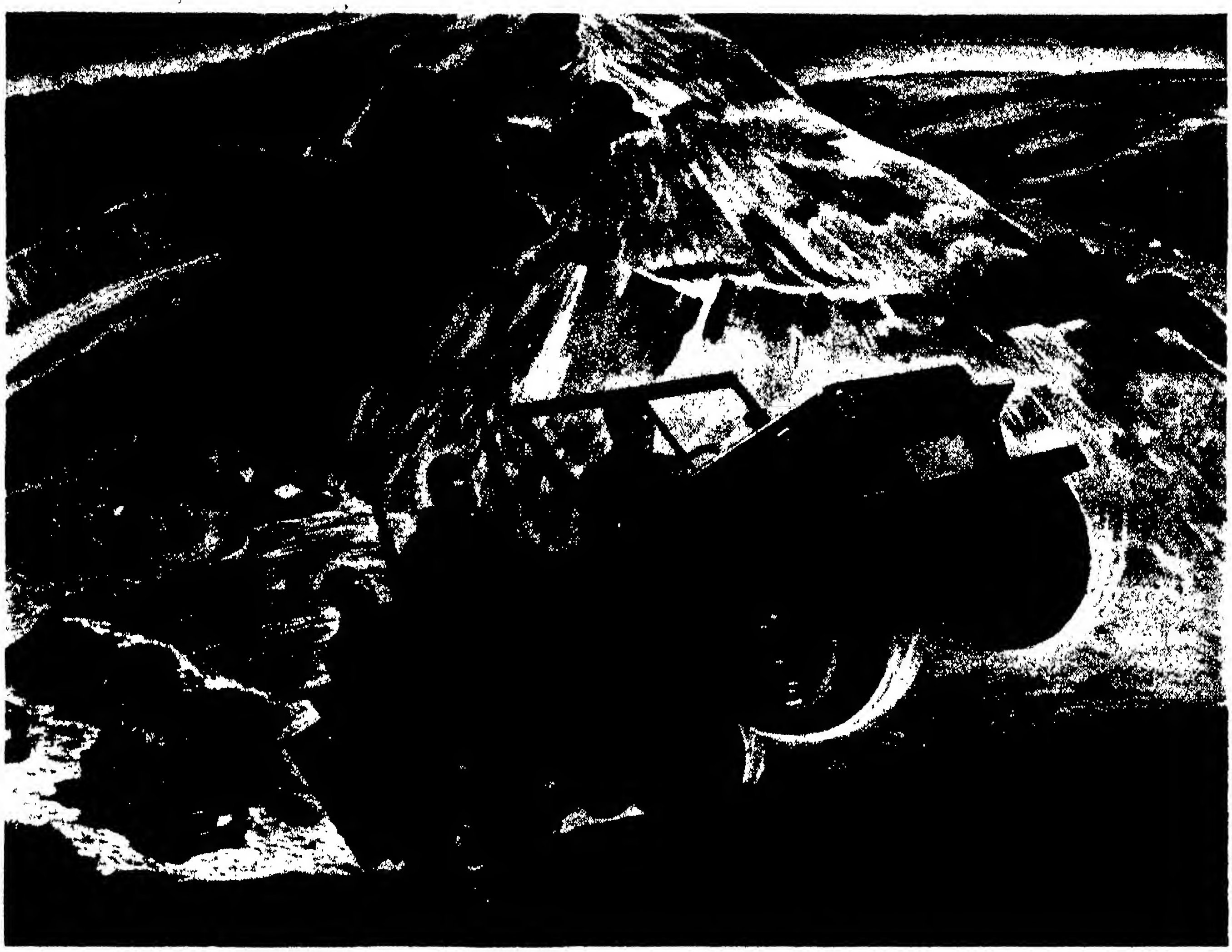
The possibility of increasing the size of flood control dams in order to develop conservation storage or power in conjunction with flood control has been studied. It appears feasible at a few sites, either under present conditions or under assumed future conditions of more extensive power development of the basin as a whole. It is contemplated that, when flood control reservoirs are constructed at sites where power might be developed, provisions will be made so that the dams may be raised in the future to provide the necessary head and storage for power. Likewise, where it is contemplated that additional storage will be provided for streamflow regulation, provision will be made either for raising the dam in the future or, where the regulation is now justified, for providing the additional storage initially.

The possible benefits deriving from small increments of permanent storage to be used for recreation were evaluated, and found, in a few cases, to equal or exceed the costs of providing the additional storage. Such additional storage provides benefits of a local character, and may be provided at almost any of the sites if local interests bear the increment of cost. Recreation benefits are always realized wherever conservation storage is provided.

Construction is now under way on the Surry Mountain, Knightville, and Birch Hill reservoirs. Levees and flood walls at Northampton, Springfield, Chicopee, and Holyoke, Massachusetts, are completed or well along toward completion, and those at Hartford and East Hartford, Connecticut, are under active construction.

Flood control in the Connecticut River Valley is under the general direction of the Chief of Engineers, U. S. Army.

Construction work on Surry Mountain Dam on the Ashuelot River above Keene, New Hampshire



Insulate to Aid Defense

Home Insulation, for New or Old Houses, Will Save Fuel, Keep Uniform Temperature

HARLAND MANCHESTER

IF THE walls of your house were full of holes, and 30 cents out of every dollar you paid for heat went to warm the great outdoors, you could see right away that it would save money to plug the holes.

Well, your walls *are* full of holes, in effect. Every time you stoke the furnace you are straining your back to melt the snow on your roof.

This is the simple lesson that a dozen public and private agencies have been dinning into the ears of the nation's householders ever since it became obvious that freight car and tanker shortages might jeopardize the supply of home fuel this winter.

There are 37,000,000 dwelling units in the United States, and most of their walls and roofs leak heat badly. The Bureau of Mines estimates that our domestic heat bill thus is $1,000,000,000 a year larger than it needs to be.

The experts will give you the remedy in one word—insulate. If you are building a new house, insulation has become a "must." Your architect or contractor will help you select from a wide variety of insulating materials the one best fitted for your needs. Insulation may add from 2 to 3 percent to the cost of the house; if so, you will get the money back many-fold. Sometimes it actually costs nothing because you need not install so large a furnace. And perhaps, with a smaller furnace, you can do with a smaller cellar—or none at all, and save still more money.

If you are living in an uninsulated house, fill the empty spaces in your walls and ceilings with insulation, put on storm windows, and tack weather-stripping around your windows and doors. You will save money to pay your income tax, and release fuel and rolling stock to keep the defense plants going. If you haven't the ready cash, a loan for the improvement is easy to obtain (the FHA will insure loans for insulating houses, old or new) or the firms which insulate houses have instalment terms so moderate that the saving in fuel will take care of the payments. It is not a gamble—nearly a million homes have already been insulated in this manner.

The investment in home insulation should pay for itself in five years on an average. Then you begin to pocket the fuel dividend; meanwhile, you will have fewer drafts, a quicker warm-up on cold mornings, a cooler house in summer, and additional fire protection.

THE principle is simple. Heat always travels from a warmer to a cooler surface. In winter, the walls and roof of a house conduct heat outward just as heat is conducted toward the handle of a spoon when you stir hot coffee with it. Summer heat travels inward the same way. Porous insulating materials contain vast numbers of minute trapped air cells which retard the flow of heat.

The history of mineral wool, now widely used in home insulating, goes back a full century to a town in Wales, where it was made in small quantities for use in a factory. A house in Salem, Virginia, was treated with it nearly 50 years ago.

But until comparatively recently, it was difficult and expensive to insulate a house once it was built. In 1928, however, a cheap method was devised for doing this work. Holes were cut in the sides of a house near the eaves and compressed air was used to blow the loose wool through a hose into the wall spaces. This system is now widely used. Mineral wool comes in shreds which you can buy by the bagful; it is sold in "bats"— rectangular, paper-wrapped sections just wide enough to fit between the studs of a wall; and it is available in "blankets" of the same width, which any householder can unroll and tack between rafters or studs. There is a form for every use, and sometimes two or more forms are used in the same house.

Mineral wool is made from rocks and smelter slag. Nature has been producing it in volcanoes for countless centuries. Sometimes when a stiff gale whistles over the crater of Mount Pele in Hawaii, molten lava is blown into fine silky threads which the winds carry for miles. The natives used to say the goddess Pele was tearing her hair in rage.

Today, man-made volcanoes in 18 states, their red-hot craters roaring like the crack of doom, are turning out mineral wool. Piles of slag, which looks like field stone, are hoisted to the tops of steel towers three stories high and some ten feet in diameter. These "volcanoes" are upside-down. Slag, coke, and limestone slide into the lofty maw of the furnace, which no one dares to look at without a mask. Far below, the "eruption" takes place. A stream of molten slag no larger than your thumb pours forth from the base of the cupola. A horizontal jet of steam hits this stream and shatters the molten rock into thousands of small comets which fly hissing and spitting through an aperture into a barn-like chamber, lined with steel. The shot-like heads of the comets face the steam and their tails of fire stream before them. The little comets fall on a conveyor and cool to form a grayish, fleecy substance which, when the shot is combed out, is strikingly similar in appearance to wool from the sheep's back.

Seventy-five firms all the way from New Jersey to California are making mineral wool, and prices have gone down 40 percent in the last five years.

To conserve fuel in this time of national emergency, it has been suggested that all householders be asked to keep their homes five degrees cooler than customary during the coming Winter. Much greater fuel economies can be made by insulating, with no sacrifice of comfort. Thousands of home-owners have discovered this fact, and savings have been figured out to the last cent in a number of controlled tests. Two winters ago Mrs. Harriet Wilson and her son lived in twin houses at New Hyde Park, Long Island, identical in every respect save that the son's

house was insulated and the other was not. They used the same type of oil-burners and the same grade of fuel oil and regulated the temperature by thermostat. Mrs. Wilson, who kept the figures, found at the end of the winter that her fuel bill was $191.52, while fuel for her son's insulated house cost only $155.68—a saving of about 19 percent.

Although both houses were kept at the same temperature, a test extending over a period of five days proved that because of fewer drafts and more even distribution of heat in the insulated house, it was comfortable when the thermostat was set five degrees cooler than in the other house.

How much coal or oil you can save obviously depends on the climate, the type of construction, and the kind of heater and fuel you are using. Tests conducted in low-cost houses in North Carolina by the TVA revealed that complete wall, floor, and roof insulation cut the fuel bill as much as 44.75 percent. And John B. Rodee, of the Pierce Laboratory of Hygiene, in New Haven, states that the heat bill of a small house in Milwaukee can be cut from $75 to $42 annually by insulating completely with mineral wool.

Even if you do not do the whole job at once, partial insulation pays dividends. One of the simplest approaches is to begin with the attic. The day after a snowstorm it is easy to see which attics are without insulation; the snow is melting much faster on those roofs. Wasted furnace heat is melting it.

Any home owner can prevent this particular leakage of heat with a small expenditure of money and work. If the attic has no floor, or if the boards can be easily removed, he can buy loose mineral wool or some other "fill" type of insulation and spread it between the ceiling joists to a thickness of three or four inches. Or he can tack prefabricated blankets between the rafters, covering the whole with insulating board. This often produces extra living space in addition to saving fuel. In a small house, the cost of the material might run between $20 and $35. Engineers of the U. S. Housing Authority recently estimated that, in one project, every square foot of roof insulation would save three and a half pounds of coal a year.

Many insulating materials have given good service in various localities. Eel grass quilted between paper has been used for more than 50 years; redwood bark is popular on the West Coast; corn stalks, flax stalks, palmetto roots, and other vegetable products are used. Wood particles, processed to open up the fiber and make a kind of wool, provide effective insulation. There are a number of insulating wall boards which also add structural strength; one of the most widely used is made of bagasse, which is sugar cane after the juice has been extracted. There are metal-coated papers which keep the heat in by reflection; aluminum foil, now difficult to obtain, is an example. And there is vermiculite, a mica-like material mined in Montana, which is processed to form feather-light pellets used as loose fill. In deciding which material is best for his house and his locality, the home-builder should profit by the experience of his neighbors and consult local construction experts.

If insulation did no more than cut the heating bill, that would be enough to justify its wide use, but it throws in several bonuses for good measure. Attic insulation keeps out the heat of the sun in summer time. Dark roofs absorb the sun's heat readily, and often on warm, sunny days, shingles or slate are as hot as 140 degrees. The heat penetrates the roof rapidly, but if there is insulation beneath your roof or attic floor and ventilators in the gables, little of it gets through to your living quarters. Wall insulation also plays an important part in keeping the house cool. In air-conditioned houses, complete insulation is an economic necessity.

Wall-paper keeps its appearance longer on an insulated wall. It has been found that without insulation, there is greater variation in the temperature of different parts of the wall, and that this causes uneven condensation of vapor. Dust settles on the more humid areas, making alternate light and dark stripes along lath and beam locations. Uniformity of room temperature and lack of drafts likewise make for warmer air near the floors, so the children can play more safely.

And as a final, extra dividend, mineral wool cannot possibly be ignited. It is, after all, rock. Tests show that a wall filled with mineral wool retards fire by about an hour, thereby vastly increasing the chances of the department getting to the scene on time.

It is no wonder that mortgage lenders encourage the insulation of houses. "If a man likes the house he lives in, he'll keep up the payments," they say. And more than any other housing development, insulation has stimulated a new approach to home-building, familiar to anyone who drives a car, but often overlooked in the past by the family buying a house—the idea that the upkeep is fully as important as the original cost. Insulation cuts down the upkeep, and makes it easier for a man to keep his home, come depression, war, or inflation.

• • •

LESS EYESTRAIN

Magnifying Binocular Loupe of Many Uses

Stamp collectors and others who have hobbies or do work requiring close reading will find use for the

For philatelists

new type binocular loupe shown in one of our illustrations. The special lenses used in this loupe, according to the American Optical Company, magnify objects and relax strained eye muscles.

TOUCH-UP

Car Owners Can Match Factory Colors

Minor scratches and damages to the finish of automobiles can now be quickly re-touched by the owner himself, with every assurance that the touch-up color will exactly match that of the original factory finish. This is made possible by the appearance on the

market of Dupli-Color, a paint that is made specifically for the purpose and is available in 300 different colors. The touch-up paint comes complete with a convenient brush in the cap, and sandpaper for preparation of the surface.

It is claimed that Dupli-Color dries in 20 minutes and can be polished four hours after application.

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PENALTY: In Jugoslavia, and some other European countries, when policemen capture a speeder, there are no accusing words or bickering over a ticket. Officers simply let the air out of all tires, tip their hats, and go on their way. The driver's session with a tire pump which follows is a lesson that he doesn't forget in a hurry.

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GAS MILEAGE

450 Miles Per Gallon — If . . .

GASOLINE is sufficiently powerful to propel a car 450 miles to the gallon, petroleum technologists say, if means could be devised to obtain complete efficiency of consumption.

With 14 gallons of gasoline a new model of any popular make could do 6300 miles at 20 miles per hour on a perfectly level road, provided there were no power losses through friction, heat radiation, wind resistance, and a few other factors.

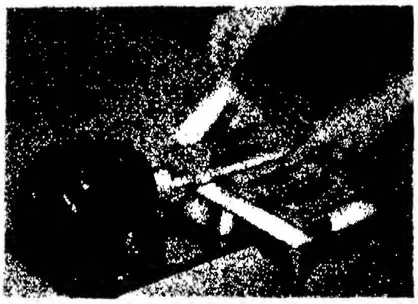
The trouble, it is explained, is not in the gasoline, one gallon of which contains 99,000,000 foot-pounds of potential power, but in the difficulty of building vehicles and highways which will permit complete advantage to be taken of this dynamic fuel.

Scientific progress will do much to improve operating efficiency of the motor vehicle, and also will improve the highway, it is believed, but the complete elimination of power losses cannot even be imagined at the present time—and probably not in the future.

GLUE SPREADER

Speeds Up Hand-Labeling Jobs

LABELS from the very smallest up to those eight inches wide can be fed through the glue spreading machine illustrated in these columns without danger of curling or of being coated with too much or too



The adhesive is regulated

little adhesive. Thus there is assured at all times ample glue to do the job, but with no wastage.

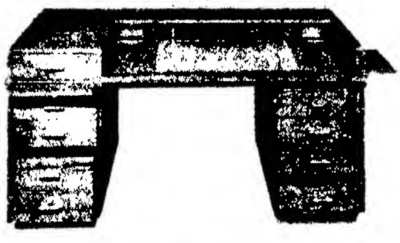
In operating the device, the labels are located between adjustable guides and are brought into contact with the glue-spreading roller one at a time. Small fingers on the delivery side of the device lift the label so that the operator can pick it off by the corner. Known as the Labelit, manufactured by the Alsop Engineering Corporation, the device will apply all types of adhesives to plain, lacquered, or varnished paper labels and to cellophane and cloth labels.

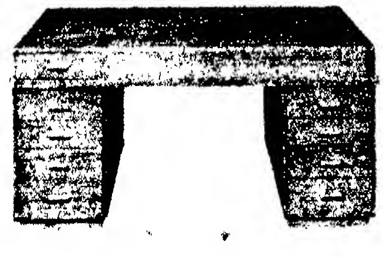
DESK

Two Tops in One Unit

EXECUTIVES in many branches of business and industry will be interested in the new Duplex "Two-Top" Desk recently developed by the Duplex Desk Company. As one of our illustration shows, this desk may be considered as a modernized form of the old roll-top desk, but with added advantages.

When the top of this new desk, composed of closely matched and fitted ribs, is pushed back, a work-





Streamlined roll-top

ing space is disclosed, complete with pigeon holes. When the movable top is pulled forward, any papers and documents on the working surface are covered with the movable top which becomes a second working surface, clear of all impediments. The movable top can be locked securely in the closed position.

PSYCHIC RESEARCH

• Scientific American, in collaboration with The Universal Council for Psychic Research, offers $15,000 to any medium who can produce a spiritistic effect or a supernatural manifestation under the rules and regulations published on page 210 of our April 1941 issue. Further reports of The Scientific American Committee for the Investigation of Psychic Phenomena will be published in forthcoming issues. •

NYLON THREAD

Synthetic Material Available for Home Use

TESTS have shown that Nylon thread, manufactured by Belding-Heminway - Corticelli Company, and now available at leading department and chain stores throughout the country, has great strength and elasticity. Thus it can be used for both hand sewing and machine stitching, producing garment seams which will stretch under unusual strain without danger of breaking the stitches. Bias seams, too, stand the strain of longitudinal stretching. Nylon thread is also resistant to rot from perspiration, does not shrink when a garment is dry-cleaned or washed, is not adversely affected by normal ironing conditions, but, as with all fine fabrics, use of a very hot iron should be avoided.

SEARCHLIGHT

High Intensity, for Emergency Use

ANNOUNCED in these columns a year or so ago was a high-intensity, battery-operated, portable searchlight designed for emergency use. By combining excessive battery drain with a bulb operating on an "over-load," a tremendously high light out-put was achieved. Because of the method of operation, however, this searchlight had an operating life of only six minutes.

Now the Burgess portable searchlight has been redesigned and a

180,000 beam candle-power

case provided which holds two 45-volt B batteries provided with simple plug-in connections. With this new arrangement this searchlight will supply 180,000 beam candle-power for approximately 35 minutes. The two batteries are wired in parallel and supply current to a 22-volt spotlight bulb.

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TRAVEL: It is estimated by the Automobile Manufacturers Association that 2100 American towns and cities ranging from 2500 up to 50,000 population have grown up without interurban mass transportation systems of their own. The combined population of nearly 12,000,000 depends for routine movements upon private cars.

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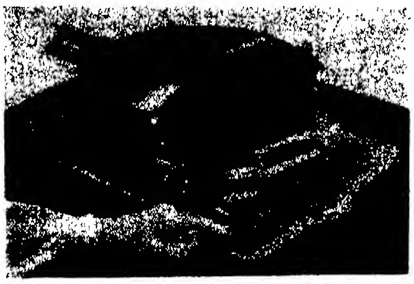
PHONOGRAPH

Tandem Tone Arm Plays Both Sides of Disk

WITH one of the new RCA victrolas recently placed on the market, it is possible to stack 15 records on the automatic mechanism and then be entertained with two hours of uninterrupted music at the touch of a button. All this is accomplished by the use of a new type automatic record changer which plays both sides of phonograph records without turning them over. Heart of the system is a tandem tone arm, shown in one of our illustrations, which consists of two arms and two pickups, one for playing the top side of the record and the other for reproducing the lower side.

When the starting button of this new phonograph is pressed, the



Continuous music for two hours

tandem tone arm automatically swings over and plays the top side of the bottom record of the stack, which has been dropped to the turntable. After reaching the end of the record, the tandem arm swings clear while the direction of the turntable is reversed. The tone arm then rises far enough to make contact with the bottom side of the record. After the first record has been played on both sides, it is deposited gently in a felt-lined compartment, whereupon another record from the bottom of the stack drops into place and the cycle is repeated until all the records have been played.

Reproduction of the records is accomplished through the use of a carefully ground sapphire point which replaces the needle. This tracks in the record groove with a minimum of pressure, assuring almost indefinite life for both the sapphire point and the records.

GRASS STUDY

Made-to-Order Weather Aids Work

SCIENTISTS of the U. S. Regional Pasture Laboratory, State College, Pennsylvania, have just set up a new "climate maker" to test pasture plants in controlled environments. Made-to-order weather will aid U. S. Department of Agriculture research in breeding improved grasses and legumes and in improving pasture management practices.

The "climate maker" is a heavily insulated cabinet with four large chambers where sample plants can be grown under controlled light, temperature, and moisture. The chambers have outer doors of refrigerator type, and inner doors fitted with observation windows. Above each chamber a bank of fluorescent lamps, insulated by plate glass, provides maximum light with minimum heat.

Air conditions and other environmental factors can be made to vary as they do on ordinary days during a growing season. Special apparatus controls the temperature, humidity, and flow of air in each chamber. Soil temperature, moisture content, and nutritional value are under control. Varying lengths of day and different light intensities simulating cloudy or clear weather can be provided. Recording devices trace an accurate, continuous account of the manufactured weather and soil conditions inside the chambers.

INK

Water Set, for Letter-Press Printing

VIRTUALLY without odor, a new printing ink sets by application of water spray or vapor. Known as Vaposet ink, it dries almost instantaneously, the water vapor rapidly diluting the ink solvent in the printed impression.

IT REFLECTS

Many Uses for Adhesive Glass-Sphere Surface

TURNING night into day and making dark ways safe ways is the figurative function of Scotchlite, a reflecting medium recently placed on the market by Minnesota Mining & Manufacturing Company. Comprised of tiny glass spheres which reflect light back to the source of light, Scotchlite is finding many new uses. Latest of these uses is on the Mississippi River where the United States Coast Guard has been making tests over a six-mile stretch below St. Paul. While the test results are still under consideration, photographs taken on the test trips indicate that the buoys and shore markers coated with the material could be seen plainly and that the light reflected by these markers was visible for distances of upwards of half a mile.

These tests gave rise to consideration of the material for other uses on water; boating enthusiasts are experimenting with it for use on docks and on the sterns of the pleasure craft themselves. Heretofore, the reflecting medium has been used as a safety measure in marking bridge abutments, guard rails, and railroad cross bucks, as well as for commercial advertising purposes and for outlining rear ends of night-riding trucks.

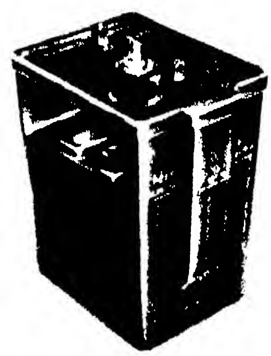
Small glass spheres, some 5000 of them per square inch, are coated on a treated fiber backing and bonded to the backing by means of a pigmented binder which has been found capable of resisting outdoor weather conditions for a period of upwards of two years.

On the reverse side from the sphere-coated surface, there is a coat of cement which adheres to the sign or marker it is desired to illuminate at night. During the day, the sign or marker will have its customary appearance; at night, when light shines on the coated surface, a glare-less reflection gives the coated object its daytime appearance.

BATTERY

A NEW storage battery for use in portable radio sets has been developed by the Willard Storage Battery Company and is being featured in the recently introduced General Electric self-charging portable receiver.

Development of the new battery makes possible the construction of a portable radio set which can be depended upon to give consistent service with a minimum of attention from its owner. In its application in portable receivers, the battery is used to supply both "A" and "B" power — the former direct, and the latter by means of vibrator conversion.



Supplies "A" and "B" power

A safe, clean, silent charger, built into the receiver itself, permits recharging the battery by simply plugging into an A.C. electric light socket. Recharging may be accomplished while the set is being operated on alternating current, or while idle. In any case, use of the set needn't be foregone when recharging becomes necessary for, even if A.C. is unavailable, provision is made for recharging the battery from the storage battery in one's car.

This new battery measures 4

inches long by 3 inches wide, and is 5½ inches high. Its case is formed of a strong, acid-proof, transparent plastic. This transparency makes it easy to see the quantity of electrolyte in the battery, as well as the built-in charge indicator. The green ball sinks when the battery is 10 percent discharged; white ball when 50 percent discharged; the red ball when completely discharged. The balls float again as the battery takes charge.

A spill-proof cover is provided to prevent loss of the electrolyte. This makes it possible to operate the receiver in a tilted position, on its side, or, for that matter, upside down. A new type of electrolyte-retaining insulation soaks up the electrolyte like a sponge, keeps the solution in contact with the plates and greatly reduces the quantity of free solution required.

BOMB TAXI

Transports Suspicious Packages to Safety

THE Bridgeport, Connecticut, Police Department has constructed a unique "bomb taxi" consisting of a large tank of ⅜-inch boiler iron mounted on a sheet iron platform. The tank and platform are mounted on a heavy two-wheeled chassis with heavy-duty springs acting as cushions. No bolts were used in the construction of the tank. One-inch cable is wound around the tank and welded every few inches. A heavy iron mesh net covers the tank to prevent particles from flying out of the tank when the bomb explodes.

When a bomb or suspicious package is discovered, the bomb taxi is towed to the spot. The bomb is placed in the tank which is parked in the center of the street. If the bomb does not explode, the taxi is then hauled to an open lot where trained technicians use a half-stick of dynamite to destroy the package.—*Fire Engineering.*

MONEY'S WORTH

Weather Services Cost Each Citizen Five Cents A Year

SERVICES of the United States Weather Bureau cost each citizen an average of only five cents a year, Merrill Bernard, supervising hydrologist of the Bureau recently stated. Among the agencies this five cents keeps at work throughout the year, Mr. Bernard listed the following:

About 40 radio-sonde stations, sending up balloons carrying automatic instrument kits, that automatically report by radio what the weather is like "up there."

Wind-study stations — 144 of them—that send up small balloons, and by means of instrumental "tracking" obtain data on height, direction, and velocity of air currents high aloft.

About 300 first-order stations in principal cities and at airports. These are the places you think of when you say "Weather Bureau." Meteorologists stationed there not only forecast tomorrow's weather; they collect data on rainfall, temperature, atmospheric pressure, wind, cloudiness, river stages, and a lot of other things needed by aviators, farmers, shippers, and other persons whose lives are in constant critical contact with the weather.

Automatic rainfall stations, now numbering about 2000, where precipitation is automatically measured and recorded, with only occasional human attendance.

More than 5000 co-operative stations, managed by volunteer observers, usually working without

salary. Their records fill in the gaps between the less numerous first-order stations with government-paid staffs.—*Science Service.*

DRAWING BOARD

Illuminated for Working on Stencils

Designed for holding duplicator stencils in position so that hand work may be done on them, a new illuminated drawing board called Dupliscope has been placed on the market by Remington Rand, Inc.

The board itself, faced with a sheet of flashed opal glass, is supported by a hinged assembly that permits adjustment to a number of

Throws light on the job

positions. On the face of the board are scales to assist in the drawing work and a T-square with a locking clamp. The T-square may be used either vertically or horizontally.

Built into the back of the board is a light source which is connected through a toggle switch to an extension cord.

FRESH FRUIT

Inexpensive Treatment Solves Salad Preparation

Every housewife and chef knows that such sliced fruits as apples, bananas, nectarines, peaches and pears quickly discolor and become unappetizing in appearance on exposure to air. In terms of pantry labor this has meant that all sliced fresh fruits must be prepared at the last minute—practically while the other food is being served—and this has eliminated quantity serving at banquets.

Scientists at the Boyce Thompson Institute for Plant Research, Inc., at Yonkers, New York, worked on the problem and discovered a non-toxic chemical, thiocarbamide, which would effectively prevent browning of cut plant tissue. It has been made available, under the name Frulite, in tablet form.

A tablet of thiocarbamide dissolved in a quart of cold water is adequate to treat a quantity of sliced fruit and if any of the solution is left, it may be held for subsequent use. The fruit, cut to the desired shapes and placed in a sieve, is immersed in the solution for not more than 30 seconds, drained, and put into the refrigerator.

Sliced fresh fruit so treated will retain its normal color at room temperature for one day; in frozen condition, it will not discolor even after many months, and sliced apples, treated previous to drying, will retain their full color two to three months at room temperature or for a year in cold storage.

PLASTER PAINT

Can be Applied to Day-Old Surfaces

Where it has formerly been necessary to wait several weeks for plaster or masonry to dry before an oil paint would adhere satisfactorily to the surface, it is now possible to apply a newly developed oil paint when the plaster or masonry is only a day old.

This new paint, called "Bondlite" by the manufacturer, The Wilbur & Williams Company, is so compounded that it is not affected by lime or alkali. At the same time it is a "breathing" paint which does not seal moisture into the surface to which it is applied, but allows the moisture to dry out naturally as it should.

It is claimed that "Bondlite" has all the qualities of a high-grade paint and is durable. It can be obtained in both an interior and exterior mixture, dries in about an hour, and is as washable as other good-grade oil paints.

MOISTENER

For Labels, Stamps, Envelopes

A three-inch wide adjustable brush, the base of which rests in a water reservoir, does a versatile job of moistening in a device placed on the market by E. W.

Pike and Company. The unit, weighted so that it hugs the desk or other surface on which it is placed, is provided with a curved metal guide so that all surfaces to be moistened, from postage stamps to large envelopes or labels, can be quickly and easily passed over the end of the brush where just sufficient moisture is supplied to do the job. Multiple moistening of envelope flaps may be accomplished by "fanning" the envelopes and passing the flaps through the device as shown above.

It licks one or a dozen

In addition, the brush of the device serves as a ready means of moistening the finger-tips preparatory to counting money, sorting papers, and so on.

INKLESS RECORDER

Has Chart Speed of Only One Inch per Day

For use in many central-station and industrial applications, a newly designed low-speed chart record can supplement high-speed recorders and telescope a record of 30 days of electrical operation into a chart only 30 inches long.

This new instrument, announced by the Meter Division of the General Electric Company, has a chart speed of only one inch per day. Thus the operating record for an entire month can be checked at a glance; unusual conditions indicated on the 30-inch chart can then be located quickly and studied more closely on the regular high-speed recorder.

The one-inch-per-day speed of the new recorder is made possible by the inkless recording mechanism which makes an impression by pressing the chart against a typewriter ribbon. The inkless feature obviates the freezing and evaporating difficulties in extreme temperatures inherent with pen-and-ink mechanisms; the recorder will function accurately in temperatures ranging from —10 to 120 degrees, Fahrenheit.

Industrial Growth

New Products and Processes That Reflect Applications of Research to Industrial Production

CLAMP

Holds Work With One-Ton Grip

FOR holding work in position on any routine jobs in the shop, a new model, deep throat, toggle-action clamp has been announced by Knu-Vise, Inc. The lower jaw of the "Klampacto," as the new clamp is called, swings clear of the work when released. Two handles are provided so that it is unnecessary to hold both the clamp and the work when fixing it in position. A squeeze of the hand applies 2000 pounds of pressure to the jaws. This clamp is available in three models with five-inch, six-inch, and ten-inch jaws.

Grips securely

PAINT

Substitute for Aluminum Paint Has New Features

COATING qualities formerly found only in aluminum paints are provided by a new type of paint which uses a penetrating oil vehicle. It is reported that this new surface coat, known as Totrust, produced by The Wilbur and Williams Company, will serve many purposes just as well as does aluminum paint, yet is much less expensive and is not affected by priority rulings.

This new coating material can be applied over moist surfaces, directly on galvanized metals, or to surfaces that have rusted to any degree. The penetrating quality of the vehicle enables the paint to penetrate pin holes and rusted pits in the metal, expelling any moisture and surrounding and effectively isolating any particles of rust. The resulting film is said to be hard and durable, yet flexible. It is available in a light gray shade that is claimed to have approximately the same light reflection as aluminum paint.

BRAZER

Compact Portable Unit for Silver Soldering

WHEREVER soldered joints are required in the construction of motors, transformers, various types of fittings, carbide tool tips, and the hundred and one other applications in various industries, use will be found for a new electrical brazer designed for the application of silver solder. This portable device, known as the Ideal Brazer, consists of a power unit or transformer and

Brazing pliers in use

a pair of electrical heating pliers. When the part to be soldered is held in the pliers and the secondary circuit is closed, the part is quickly heated to brazing temperature. Heat is accurately controlled by a foot switch and the jaw ends of the heating pliers are removable so that different shaped jaws can be used, depending on the work to be held.

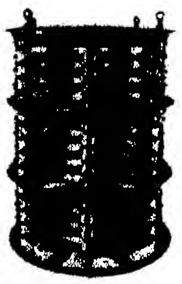
The brazer operates on 230-volt or 440-volt power supply, the secondary voltage being reduced to only ten volts.

HEATERS

Immersion Type Booster

For Industrial Use

In many coating and saturating processes involving the use of heated asphalts, oils, paraffins, waxes, resins, creosote, varnishes, insulating varnishes, and so on, it is necessary to increase or maintain temperature of the material by applying heat in the line between storage tank and the container where processing occurs. For use in such cases there has recently been designed an immersion type booster heater available in capacities ranging from 10 to 100 kilowatts. These heaters, known as Falcon and manufactured by H. O. Swoboda, Inc., consist of spirally coiled heater strips arranged to form a compact unit. The heater is installed in a sealed tank built in the pipe line between storage vessel and coating or saturating tank. Temperature is maintained uniformly by means of automatic controls. Only two simple connections are necessary for connecting the heater to the electric circuit.



For booster service

The Falcon booster heater is applicable for use with any materials having electrical insulation properties (non-conductors). In operation, the "bare" electric coils are immersed in the material to be heated. In this manner a direct thermal contact is established, in-

suring that practically all the heat generated is transferred to the material, and providing an improvement over the ordinary radiant and strip heaters normally used on the exterior of tanks. Due to the large surface area of the heating elements, and the fact that the heater is designed for operation at an extremely low watt density per unit of heat transfer surface, no temperature gradient is set up between heater and material. This prevents disintegration accompanying other methods which operate at a higher surface temperature than that of the charge.

GLOVES

Flexible, Long Wearing, Protect Skin

OCCUPATIONAL skin diseases of various types are to be found among workmen whose hands are constantly exposed to various types of oils and solvents. For men working under these conditions a new type of glove made of a material called Resistoflex PVA has been developed which provides complete protection yet is not bulky enough to hinder ordinary manual operations.

Since the material from which these gloves are made contains no sulfur, they can be used when handling finely polished metal surfaces without danger of tarnishing.

GOGGLES

Plastic Side Shields in Welder's Glasses

ADEQUATE protection for welder's eyes is provided by a new shield-equipped goggle known as Arc Ban, placed on the market by

Ventilated, protective

Bausch and Lomb Optical Company. Not only do the lenses provide protection, but louvres in the side shields, which are made of a composition material, keep out all light while admitting sufficient air for ventilation.

The eye cups are so designed as to conform to facial contours. These goggles are available in types for welders who need corrective spectacles and for those who do not.

TOOLS

Flexible Shafts, Wide Speed Range

A NEW line of hand tools specifically designed for shop requirements where a wide range of speeds is called for have been made

Attaching flexible shaft to the worm-gear, low-speed shaft end

available by the Foredom Electric Company. A simple and quick method of changeover from direct to worm-gear reduction is provided by a double-end shaft on the motor. For direct drive, the flexible shaft assembly is screwed into one end of the motor; for worm-gear drive, the flexible shaft assembly is attached to opposite end of the motor.

Speeds available with this tool are stated to be from 2000 to 14,000 revolutions per minute with direct drive and from 500 to 5000 at the geared end. Motors supplied are universal, air cooled.

GRINDING COMPOUND

Easily "Tailored" to Individual Jobs

A WATER-SOLUBLE cutting and grinding compound may be made from the P-96 concentrate of the

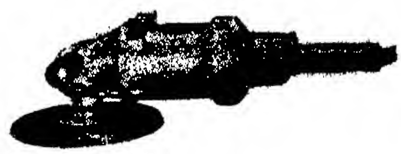
self-emulsifying degreasing solvent, Gunk, recently described in these columns, by the simple addition of light lubricating oil and a low-cost petroleum distillate. Water-soluble cutting and grinding lubricants may be prepared in exactly the proper grade to fit each particular job at hand. Variation of the quantity and type of materials used will vary the resulting compound to suit any given specifications. Such composition may then be diluted with water to form the final cutting and grinding emulsion.

The concentrated Gunk is said to impart to the emulsion, by virtue of its alkyl phenol content, a quality that leaves ferrous metal surfaces resistant to the formation of rust.

SANDER

Heavy-Duty Unit for Fast Work

DESIGNED for constant production-line use with nine-inch disks, a new Black and Decker sanding



Fast and tough

machine has been produced to meet demands for faster schedules. The sander incorporates a universal motor and a new spindle-lock for quick disk changing.

PRIMARY BATTERY

High Capacity, Indefinite Life When Idle

RAILROAD signaling systems and protective devices, as well as other applications where primary batteries have been used previously, can now be provided with a new power source which has over 70 percent more current output than any of its predecessors. Recently announced by Thomas A. Edison, Inc., this new primary battery is believed to be the most powerful of its kind ever made as a standardized product. It belongs to that group of power sources generally referred to as "copper-oxide caustic soda batteries." The electrical output is generated entirely by the chemical action of a sodium hydroxide solution on electrodes of zinc and copper oxide.

This new battery has a capacity rating of 1000 ampere-hours. When discharging, it will deliver that amount of power at any rate of current up to 22 amperes. Operating voltage is approximately .65 volts, with higher voltages obtained by connecting batteries in series. The high current output makes it possible to supply many current requirements with a single series-connected group where it was formerly necessary to use multiple-series groups.

MAGNIFIER

Compact Design For Small Parts Inspection

FOR inspecting the finish and other details on small machine parts and similar work, a practical device in-

Well lighted

corporates a large diameter lens and an incandescent lamp. This unit, known as the Spectifier, is so designed that the parts to be inspected can be passed rapidly under the lens by hand. The inspector uses both eyes; critical inspection can be made from all angles and at any reasonable distance from the lens. The device uses no focusing system and needs no holders for materials being inspected. The uniform lighting provided by this device is an important factor in standardizing on a method of inspection, eliminating objectional variations that are found when inspection is carried on under non-uniform lighting.

Ocean Air Transport

Painstaking Planning is Behind Our Transatlantic Service: A Glimpse of the Future

ALEXANDER KLEMIN
Aviation Editor, Scientific American.
Research Professor, Daniel Guggenheim School of Aeronautics, New York University

THE twenty-ninth Wilbur Wright Memorial Lecture, before the Royal Aeronautical Society in London, was delivered by J. T. Trippe, President of Pan American Airways. Mr. Trippe, with an unrivaled international reputation as an organizer of ocean air transport, gave our English friends a history of development, a masterly exposition of the scientific manner in which flights are planned and conducted, and a glimpse of the future, of which only a brief summary can be presented here.

The Boeing B-314 Clippers have rendered splendid service during the war. Individual mail loads of 13,000 pounds, in addition to 33 passengers eastbound and 35 westbound, were being transported over the Atlantic at the time when Mr. Trippe delivered his paper. The flights have been made under very difficult weather conditions at times. Yet the hint was given by the lecturer that the 84,000 pound Boeing Clippers may, in 1942, be superseded by landplanes. Why landplanes for over water service? Because emergency landings in rough water are not much safer with flying boats than with landplanes properly equipped. Boats, rafts, and the vicinity of ocean lanes are the real safeguards: even a sturdy flying-boat hull will soon yield to the pounding of the North Atlantic. Because landplanes will have cruising speeds of some 75 miles an hour faster, and faster cruising speeds are indispensable in view of high velocity westerly winds in winter. Because there is always danger of ice at North Atlantic coast points. Because heavy swells at Horta in the Azores delay passage. Because the real advance in North Atlantic flying is to be by means of non-stop operation from New York to London, and only landplanes are capable of giving this service.

Thanks to Conrad, McFee, and Forrester, almost every landlubber knows something of life at sea, of standing watch, of eight bells. But the public may not yet have learned that the Clippers are developing a routine and a life in the air, and a tradition which is very like that of a sea-going vessel. The Boeing Clippers have a crew of eleven: Captain; First Officer; Second, Third, and Fourth Officers; two engineers; two radio men; two stewards.

There are four engines on the Clippers and, with their accessibility and high endurance, it is unlikely that more than one engine will fail on a trip. There must, however, be a margin of safety in the fuel carried. The operations men calculate an actual fuel load which is computed after thorough analysis of all forecastable conditions which the plane must encounter on its planned crossing. Over and above this calculated fuel load there is placed aboard the boat 4½ hours of reserve flying fuel.

Then there is a Scientific Control of Flight. Briefly, this is a process by which the most efficient performance of the aircraft is charted through the most favorable conditions available to the flight. Before the beginning of each crossing, the crew assigned for that particular transatlantic flight, accompanied by maintenance and service engineers, inspectors, and so on, puts the ship through a test flight on which air speed and all fuel-flow indicators are calibrated and all compasses are carefully compensated.

Then the Meteorologists get to work and prepare a three-dimensional chart, prepared on the latest air-mass analysis. This third-dimensional or vertical weather chart is drawn to provide the pilot with an illustration of what conditions he is to expect and to illustrate the clouds, rain, fog, and icing areas forecast on the route. From these charts, the meteorologist divides the projected flight line into various zones. Each zone represents an area of more or less consistent winds and the lengths of each are dependent upon the location of the various pressure areas and weather fronts along the route. From

weather maps and the third-dimensional chart a Flight Forecast is prepared. This reports the state of the weather, the amount, type, and height of clouds, the estimated level at which freezing temperatures might be encountered, and wind direction and velocity at 1000, 4000, 8000, and 12,000 feet, as well as much other useful information.

From the Flight Forecast the Captain and the Airport Manager evolve the Flight Time Analysis. Taking winds at various altitudes into account, the ground speed at various altitudes and the time required to fly certain distances at these altitudes are computed. Finally, the best flight plan is determined; that is, the one which will bring the ship to its destination the most quickly, with sufficient reserve of fuel, and with some attention to fuel economy.

Finally, there is the "Howgozit Curve" which was developed by Captain Harold Gray, Chief Pilot of the Atlantic Division. To describe the "Howgozit Curve" we can do no better than to quote Mr. Trippe's own words: "Its purpose is to present to the crew aloft and to the flight watch ashore, a continuous flow of information as to the fuel reserve remaining aboard the aircraft and the fuel required for completion of the flight . . . Using the path selected in the Flight Forecast and performance charts for the plane and its engines, a curve of miles *vs* gallons is plotted. The second curve shows gallons *vs* hours of flying. The third curve is of hours *vs* miles." Similar curves are drawn for three-engined operation out of the four. All these curves are drawn solidly. As the flight proceeds, a constant record of the plane's actual fuel consumption and mileage is maintained. Along the solid curves, the First Officer draws dotted curves showing how everything is going. Hence the title, "Howgozit Curve."

Our readers will agree that the Captain of the ocean airliner is no longer merely a brave and skilful flier. He is now as skilled a planner, navigator, leader, and administrator as the captain of a crack ocean liner.

SOARING

Interest Stimulated by Military Uses

THE Twelfth Annual National Soaring Contest held at Elmira was as successful as usual, with fine performances turned in by the winners, and a larger gathering of enthusiasts than ever. Gliding is probably coming into its own at last in the United States.

General Henry H. Arnold, Deputy Chief of Staff, has stated: "We have been studying gliders and their possibilities for usefulness in connection with national defense and are preparing a glider program including training of glider pilots and procurement of several types of gliders. We consider gliders essential to possible operations of all modern air forces." General Arnold also mentioned the fact that 12 Army Air Corps officers recently completed glider training.

Major Lester D. Gardner, Executive Vice-president of the Institute of Aeronautical Sciences, predicted Federal stimulation of glider training and thought that an inexpensive and excellent way of selecting power-plane pilots was to glean them from the ranks of thousands of youths training with gliders.

In general, there is a feeling that gliders may serve to bridge the

A sailplane for the Army

Of promising military value

gap between model building and power flying; that gliding should create a reservoir of skilled fliers; and that the military uses of the glider in transporting men to hostile territory are most promising. —*A. K.*

TRAINER

Learning Flight Fundamentals on the Ground

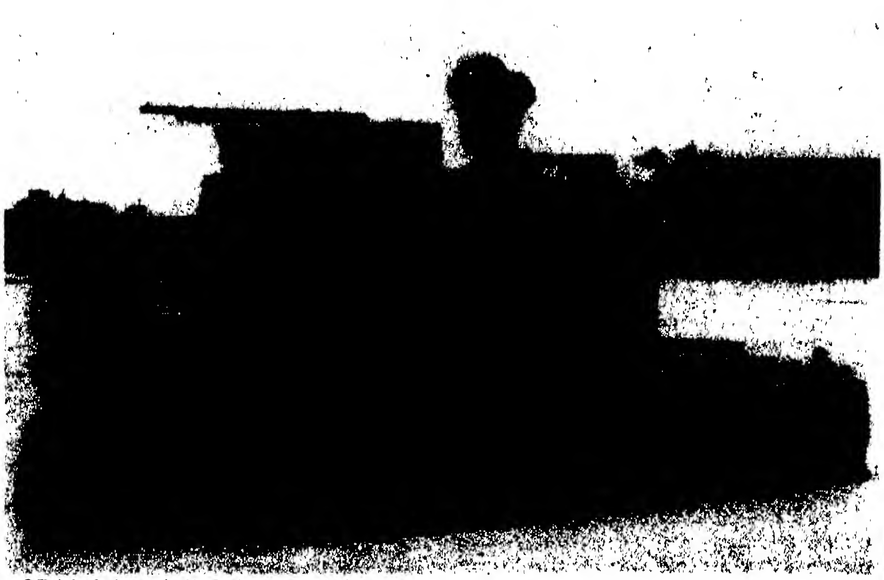
A CURIOUS device, known as the "Preflight Reflex Trainer," and designed to teach a student how to coördinate stick and rudder controls before actual flight training, has been built at Wright Field by Major G. V. Holloman of the Army Air Corps. Equipped with a standard airplane seat and regular service controls—that is, rudder, stick, throttle, brake, and gun trigger—the preflight trainer can be operated on any large pavement. It is powered by a small gasoline engine. The cockpit, suspended in a triangular frame mounted on three wheels, banks in response to the controls. Control and operation of a machine gun can be practiced in conjunction with operation of the usual flight controls. A warning horn informs the student when he over-banks or makes any other mistake in coödinating the controls. The apparatus was conceived jointly by Colonel William C. Ocher and Major Carl J. Crane.

In these days when so many thousands of pilots have to be trained in short order, the preflight training may prove of real value.—*A. K.*

PRIVATE FLYING

Research Institute to Be Established

PRESIDENT of Aeronautical Corporation of America, Carl Friedlander tells us that he will establish the Aeronca Research Institute solely for the investigation of private flying problems—new designs, new materials, new conceptions. This is an excellent idea. Private flying is constantly extending, and after the "emergency," it should grow on an immense scale, particularly if research helps to solve its problems. In all probability this will be the first research institute of its kind ever established by the American aviation industry.—*A. K.*



Official photograph U. S. Army Air Corps

It has everything but wings

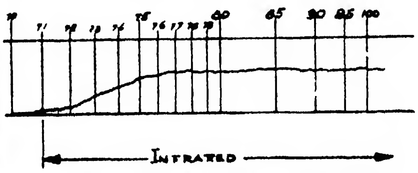
CAMERA ANGLES

Conducted by JACOB DESCHIN, A.R.P.S.

Introducing Blackout Flash

"BLACKOUT" (infra-red) flash photography, already a practical tool abroad, where it is being used by newspaper cameramen in routine press photography during blackouts, has become available in this country through the introduction, by the Wabash Photolamp Corporation, of the Blackout Superflash Bulb. Specially treated with a "black" infra-red filter jacket designed to absorb practically all the "visible" light produced inside the hydronalium wire-filled bulb, transmitting predominantly the infra-red rays invisible to the eye but having an instant effect on infra-red film in a camera, the lamp is the flash version of the black filter used with infra-red film outdoors or of similar filters used over light sources in indoor infra-red photography. Its size is the same as the Superflash bulb No. 2, but the new lamps are dipped in a special dye-lacquer solution which, when dry, provides a hard "skin-tight" filter over the entire bulb.

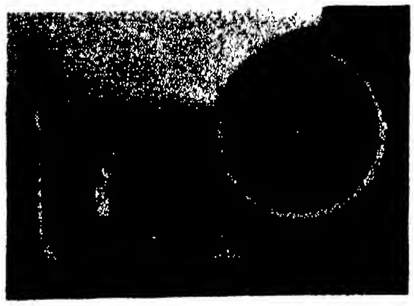
The spectrum which, revealed by a prism, shows the color composition of white light as ranging from violet and blue at one end to orange and red at the other, is generally familiar. This is known as the "visible" spectrum because these colors produce a definite sensation upon the human vision. However, the complete spectrum does not stop there; it also embraces "colors" we do not see. At the one end is the invisible ultra-violet and at the other end is the invisible infra-red.



Infra-red range, Blackout bulbs

The various sections of the spectrum are frequently identified in terms of wavelength, this being progressively shorter as one approaches the ultra-violet end of the spectrum and progressively longer as one goes towards the infra-red. Specifically, the visible spectrum is confined approximately within the limits of 4000 to 7000 Angstrom units. Infra-red photography, however, is concerned solely with the region beyond 7000 A.

The infra-red transmission of the Blackout Superflash is shown in the spectrogram reproduced here. The Wabash company, who supplied the chart, describe the light transmission of the filter as follows: About 9 percent is in the ultra-violet area. Light transmission in the red starts at 6900 A (that is, in the still visible red), gradually rising to 7500 A.



Infra-red reflector at right

The blackout bulb is used with infra-red film, available from several manufacturers. Eastman and Agfa produce it in roll film, and DuPont in 35mm rolls; Eastman also supplies the film in sheet form. The film is sensitive to ultra-violet, violet, and blue at the short end of the spectrum as well as to the infra-red at the longer end. However, being more sensitive to the shorter than to the longer wavelengths, a special filter is required that will effectively absorb or "hold back" the shorter wavelengths but freely transmit the longer. Without the selectivity thus provided by the filter, the characteristics of an infra-red photograph would be lost and the result hardly differ from normal photography. The black bulb is introduced to do this job for flash.

No special synchronizing adjustments are necessary when using black bulbs and the reflector normally employed for flash work is completely suitable for the purpose. Slightly greater efficiency, however, may be had by using a gold-plated reflecting surface, according to Wabash. A special reflector, designed by Sun Ray on recommendation of Army officials, is shown in one of the illustrations. The reflector has an adjustable hood or visor for use in blackouts as a precaution against detection by enemy aircraft flying above the photographer, since the flash is clearly visible in darkness. In the illustration, this special reflector is shown mounted on the left side of the

In a black dark-room

camera, with the synchronizer in its normal position on the right-hand side. This is to facilitate a quick change from black bulbs during a blackout or other situation, to ordinary flash bulbs afterward, the regular reflector being mounted over the battery case, as usual. The black bulbs may, of course, also be used in ordinary "open-and-shut" fashion.

On the basis of test exposures,

From a panchromatic negative . . .

using Eastman Infra-red cut film, the following table provides an accurate guide to exposure with the blackout bulb. The table presupposes, however, that pictures will be taken in a room with light-toned walls or outdoors where a similar condition can be arranged. In rooms with dark walls or outdoors, where one cannot count on the added reflection from light surfaces, one stop larger should be used. The distances refer, of course, to the number of feet separating the lamp and the subject, irrespective of the camera distance.

Distance	*f/ Stop*	*Shutter*
6 feet	*f*/8	1/50
10 "	*f*/5.6	1/50
12 "	*f*/5	1/25
14 "	*f*/4.5	1/25

The light to which the infra-red film is sensitive does not come to sharp focus on the same plane as does visible light. It is sometimes necessary, therefore, to make manual compensation for this discrepancy by racking the lens forward slightly. In practice, however, this is not always required. In the case of miniature lenses, for example, because of their short focus and consequent depth of field, compensation may be ignored, particularly if medium small stops are used. As a matter of fact, the correction required varies widely with different lenses, this variation ranging from ¼ to 3 percent of the focal length of the lens used. Dr. Walter Clark, authority on infra-red, states that "anastigmatic lenses used on hand cameras are usually satisfactory, especially if they are stopped

. . . and by infra-red

down to *f*/8 or less." He further declares that "in actual practice, most anastigmats working at *f*/4.5 and of focal length of 7 inches or less give fairly good definition at full aperture."

Wabash recommends that infra-red film exposed by flash be developed 50 percent longer than indicated time in order to hold shadow detail; to avoid burning up the highlights, they suggest soft development in some such developer as ABC Pyro or Agfa 47. We used D-76 in accordance with manufacturer's instructions—about 10 minutes in a tank at 65 degrees, Fahrenheit—with satisfactory results. Development is in total darkness or by the light of a Wratten Series 7 (Infra-red) Safelight using a 10-watt bulb and at a distance of three feet from the developing tray.

In handling infra-red film, the following precautions should be observed: use the cut-film holders having the five little knobs on the grip edge of the slide; do not use those having only three knobs as they may cause fogging of the film due to the material having a tendency to transmit heat. Infra-red rays being heat rays, any condition that may permit unusual heat to reach the films will cause fog. Therefore, do not carry the holder against the body; no camera loaded with infra-red should be kept exposed to the sun for any length of time; when loading film, do not place fingers on the material, as heat from the fingers will fog the film.

In flashing a number of bulbs, it is recommended that the photographer make some immediate disposition of the used bulbs to avoid confusion with unused bulbs. Marking with a piece of white chalk is suggested. This department found, however, that in actual practice the bulb provides its own check by a telltale corrugation on one side of the bulb, where the intense heat causes the coating to swell and then cool in irregular ridges.

The effect of infra-red light is pe-

culiar, as may be seen from the photographs of the young lady and of the two darkroom workers. Lipstick is recorded as white, veins lying under the skin show up like black lines sketched on the arms, facial tones are distorted, and red stripes on a yellow dress are practically merged into a single white tone. Comparison with the photograph taken on panchromatic film in normal photography will show the startling differences. The men in the darkroom, though clean shaven, look as though they needed another one. Old stains in clothing, though dry-cleaned, often show up clearly.

Besides blackout work, the bulb is intended for use in darkened theaters and night clubs, courtrooms, public lectures, symphony concerts, candid photography, as well as scientific research.

We have found, however, that the light produced by the flash is definitely visible, particularly so when intensified by surrounding darkness. In flashing the portrait of the young lady, we could clearly see the face of the subject bathed in a red glow during the brief flash interval. We cannot, therefore, agree that the light is "invisible" to the extent that the flash would go undetected in a darkened room. Because of the undoubted value of such a bulb, we do hope the manufacturers will experiment further with the dyes involved in order to bring about the desired improvement. Perhaps by the time this is published, the improvement will be a fact.

Fall Colorings

NATURE'S annual Fall show is here again, and a grand show it is, as usual. Unquestionably, it is a job for color, whether you shoot still or movies, or both. It is particularly attractive as a movie subject. The movement of the branches, the falling of leaves, the slow procession of clouds in a blue sky, all combine to make a perfect "set" for the movie-maker. Get a boy and a dog into the picture, walking along a winding road in the country, and you have something that looks as real as life. Don't always work with the sun behind the camera; try some shots with the sun to the side or back-lighting the leaves. Use a polarizing screen to give extra "umph" to the blue sky; you will like the dramatic effect of white clouds against the deep blue. Include a lot of close-ups and glean a lot of "oh's" and "ah's" when you show the results on the screen.

Low Viewpoint

IN OUR August, 1941, issue, we published a picture of a boat at low tide, which we described as having been photographed with the camera about six inches from the ground. One of our readers took issue with us because, he wrote, "the height of

the sea horizon is the measure of the height of the camera," and went on to say that "this indicates that the camera was considerably higher than 6 inches above the beach shown; I would estimate that the camera was about 4 feet higher than the beach on which the boat rests."

First, it is necessary to point out that the view of the boat as shown in the picture could not have been photographed except from a low angle. Secondly, it must be realized that the height of the horizon in a print is not a measure of the height of the camera. The position of the camera in the case in point was, we repeat, six inches from the ground; in making the print, the foreground was favored and part of the sky was eliminated in the interest of good composition.

Emergency Weights

WHEN in need of extra weighing units or when these have been temporarily misplaced, darkroom workers have used American coins as substitutes to give approximate equivalents, as follows:

Silver dollar	400	grains	26	grams
Half-dollar ..	200	"	13	"
Quarter-dollar ..	100	"	6½	"
Dime	40	"	2½	"
Nickel	80	"	5	"
Cent	50	"	3¼	"

When the Wind Blows

WHEN in need of extra weighing units or when these have been even a painter goes to in order to steady his easel (notice the yards of linked chain suspended in the center of the tripod easel?) when the painter himself assumed a pose that had pictorial possibilities. Such as they are, judge for yourself in the accompanying reproduction. To us, there seemed to be such movement in the shot that we have seldom seen its equal in a still picture. The pose of the painter (not posed for the shot, as he was totally oblivious to our presence), the position of the right leg, the sweep of the grass as it was blown by the wind, the formation of the clouds at the click of the shutter, all added their bit to the total impression. The exposure was on Plus X film, red filter, 1/50 of a second at $f/16$.

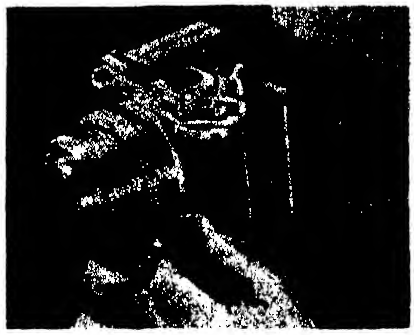
"On the Dunes"

• • •

WHAT'S NEW

In Photographic Equipment

KODAK MEDALIST ($165): 2¼ by 3¼ camera using roll film; adaptable to cut film, film-packs, and plates. All-American-built, uses 620 roll film; with accessory back, 520 film-packs and 6.5 by 9cm films and plates. Equipped with Kodak Ektar lens $f/3.5$, 100mm focal length, comprising five elements. Interior glass-air surfaces treated, reducing inter-surface reflections to minimum. Angle



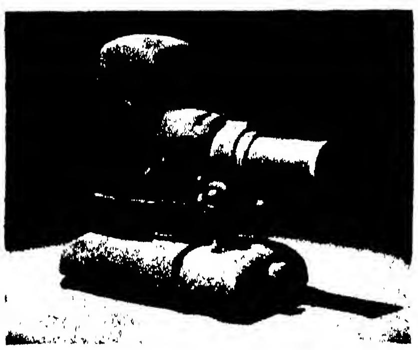
of coverage 54 degrees, flat field. Shutter special model of Kodak Supermatic No. 2, gear-train retard, presetting type, with low-inertia blades of thin spring steel; has eight apertures $f/32$ to $f/3.5$; nine speeds from 1 second to 1/400 second, plus bulb. Has built-in, delayed-exposure mechanism; cable release socket for remote control; Photoflash synchronization. Lens support consists of two helically inter-threaded tubular members; lens extended and retracted by focusing ring or micro-focusing knob. Depth of field scale, built into top of camera, coupled to operate with focusing tube after extension to picture-taking position. Range finder split-field, military type coupled to operate automatically with lens. Range finder located small fraction of an inch below eyepiece of view finder. View finder gives parallax correction automatically while range finder eyepiece shows central portion of subject field covered by view finder. Red marking for infra-red. Film transport and shutter work together, preventing double exposure.

ABBEY AMPLANE REFLECTOR ($4.75): Designed for use with midget lamps. Choice of wide or narrow beam offered. Reflector constructed with removable disk. With latter in place, flat, spot-free illumination from side to side up to 20 feet indoors

obtainable with normal diaphragm openings. Disk used for concentrated light, which leaves highly polished center exposed, allowing shots at 50 feet. With disk removed light useful for spot-lighting and special effects. Amplane surfaces silver-plated, protected by special heat-resisting and extra tough lacquer, yielding high reflection.

3A Kodak, Series III: Postcard size pictures, 3¼ by 5½ inches. Equipped with Kodak Anastigmat $f/6.3$, 170mm focal length, mounted in Kodamatic shutter with speed range 1/10 to 1/200 of a second, plus time and bulb; also delayed action. Equipped with rising front, brilliant waist-level finder adjustable for vertical or horizontal pictures; folding, metal-frame eye-level finder on side panel. Uses six-exposure No. 122 Kodak roll film.

Filmo Slide Master: For projecting two by two-inch transparencies. Features "base-up" lamp (operates with base upward); blackening deposit formed during operation of lamp not deposited on sides of lamp but is carried elsewhere in lamp, out of beam. Top of lamphouse hinged snap-cover, which automatically breaks electrical circuit as it is opened. Designed to take 500-, 750- or 1000-watt base-up lamps. No



light spill. Motor-driven fan circulates forced draft of cool air throughout projector, including area around slide. Offered with choice of 3½-, 5- or 7½-inch $f/4.5$ anastigmatic lens. Condenser includes two heat absorbing glass filters. Slide carrier of die-cast metal, with special air passages for circulation of air around slide. Operates on 100- to 125-volt AC or DC.

Crown Cable Flash Synchronizer ($3.95): Basic unit consists of standard metal cable release with synchronizing mechanism built into portion normally held in hand. May be used either as simple cable release or converted to synchronize when connected by means of electrical cord to a battery case and reflector. Features: will operate any camera using cable release; operation combination of manual and mechanical, therefore self-cocking and easy on shutter; special action, sealed in light aluminum shell, levels off differences in individual operation of cable release; stroke control element adjusts synchronizer to individual shutter; timing element fixed—preset to accommodate present-day flash bulbs; differences of adjustment in plunger length only. Device weighs slightly more than the conventional cable release.

Bolex Iris Vignetter ($10, $11.50): Closes down completely. After iris closes, special arm drops into place over last point of light, completely blacking out circle. Specially made for Leitz Hektor Rapid 27mm $f/1.4$ lens; may be adapted to all other 1 inch lenses for use on all cameras. Cameras having back-winding mechanism provide means for making satisfactory lap-dissolves with this device.

New Kalart Lens-Coupled Range Finder ($24): Model "E" supplants present Model "F." Fits all Speed Graphic cameras, Watson Press cameras, and most film-pack cameras. Streamlined in appearance, has bigger and brighter image permitting focusing even under unfavorable light conditions. Superimposed image type. Close working distance increased to 2½ feet on new shorter focal length lenses. All adjustments internal. Range finder adjustable for all lenses from 10.5 to 16.5 cm.

Wabash Blackout Superflash (60 cents each): Specially treated flash bulb for use with infra-red film when photographing in total darkness. (See lead article, Camera Angles.)

Kodak Minicolor Prints: Color prints from 35mm and Bantam size Kodachrome Transparencies. Two sizes: 2X print (2¼ by 3¼ inches), 75 cents each; 5X print (5⅜ by 7 4/5 inches), $3.50. Corners rounded, no margins. Print support is pigmented celulose acetate. Prints double varnished. Processing by Eastman Kodak Company, Rochester, New York. 5X prints returned in mounts, for horizontals 8⅜ by 10¼ inches; for verticals 8⅜ by 11 1/16 inches. Picture opening measures 5 by 7½ inches.

Kotavachrome Professional Prints: Reproduced by Eastman Kodak Company, Rochester, New York, from Kodachrome professional film transparencies. Prints range up to 30 by 40 inches from all sizes Kodachrome professional film except 11 by 14 inches and stereo sizes. Maximum print from any transparency limited to six diameters. Prices range from $12 for an 8 by 10 inch print to $90 for a 30 by 40 inch print; for additional prints from same transparency ordered at same time prices range from $6 for an 8 by 10 to $60 for a 30 by 40.

YOUR FIREARMS and FISHING TACKLE

Conducted by A. D. RATHBONE, IV

INTEREST IN FIREARMS *is traditional with American men; fishing tackle is a requisite of one of the world's oldest occupations. Scientific development of guns and tackle, in the use of which millions yearly find sport and recreation, fathers this monthly department which welcomes correspondence from readers.*

"Skeeter Trap" in Defense

SEVERAL months ago (May 1941) we talked about the "Skeeter Trap," extolled its virtues for wing-shooting practice with shotguns. Now we find this excellent little piece of mechanism, designed primarily for the scatter-gunner's recreation, assigned to a niche in the vast picture of national defense.

Residents of Pleasantville, New York, like citizens of innumerable other villages and cities throughout the nation, have formed a civilian defense unit, known as the Pleasantville Emergency Police. Some 40 or 50 men above draft age—many of them veterans of World War I—are taking a course in rudimentary police work under the guidance of Lieutenant Kenneth Romaine, of the regular Pleasantville police, and a graduate of the National Police Academy, Washington, D. C., a training institution conducted by the Federal Bureau of Investigation.

Trains emergency police

Naturally, this work involves an operating knowledge of firearms, including shotguns. To this end the "Skeeter Trap" has been put to work tossing out the little 2⅝-inch clay targets a distance of 70 to 80 feet so the embryo officers may obtain practice in shooting at moving targets. The "Skeeter Trap" was given this assignment in Pleasantville's defense preparations because it is ideally suited to the use of miniature clay targets, which cost considerably less than the regulation size used in skeet or trap shooting. As shotgun shells and flying clay targets for a body of 50 men regularly engaged in shooting practice can run to heavy expense, the combination of "Skeeter Trap" and .410 bore shotgun proved one way of keeping costs down and still providing splendid gunnery work for Pleasantville's Emergency Policemen.

On Keeping Dry

RAIN in its place is fittin' and proper; a four-day session of squally, driving showers in the course of a camping-fishing trip — when your home is your tent—can be very uncomfortable if you're not properly prepared. It used to be that a fellow lugged along a pair of rubber boots and either a poncho—which, it's true, served many purposes—or a suit of oilskins, and each item was bulky and weighed plenty. Now, however, you take a "Rain-Set," manufactured by Ironall Factories Company, the newest thing in rainwear, and adaptable to most outdoor avocations.

Made of rayon cordura fabric, a Du Pont product, the trousers and jacket that comprise a "Rain-Set" are treated with Goodyear Tire and Rubber Company's synthetic Pliosheen to provide the waterproofing. On a recent camping and angling trip we took along a "Rain-Set" for the lady-who-catches-more-fish-than-we-do, and in view of the extensive amount of moisture encountered in that four-day rainy spell, the suit was put to a thorough test.

The report of the wearer was most enthusiastic. Around camp, climbing in and out of the canoe, the two-piece

For fishing in the rain with comfort. ***Inset:*** **Carrying bag**

arrangement was found to be a distinct advantage over the conventional raincoat or poncho from the dual standpoint of keeping dry and offering far greater freedom of action. Best of all, the packed "Rain-Set" weighs but four ounces and in its Pliosheen-treated carrying bag it measures about five by eight inches, can be stored in pocket or tackle box, and will not mildew, shrink, or stretch, nor will the material become sticky or stiff. The suit is quickly slipped on over regular clothing and, in addition to keeping the entire body dry, it serves as an excellent windbreaker. With its several advantages, the "Rain-Set" will be equally welcome on the golf course, in the sail boat, and outdoors in general.

● ● ●

POT SHOTS

At Things New

WINCHESTER REPEATING ARMS COMPANY presents a new, 44-page edition of the Winchester Ammunition Guide. It is packed with up-to-date information of interest to all shooters and is free. Completely revised and amended, it contains detailed lists of all Winchester loads in shot shells and metallic cartridges, together with revised ballistic and range tables. Illustrations include all types of Winchester ammunition, trajectory diagrams, comparative sizes of cartridges, 23 types of Winchester shotguns and rifles, many other items. The guide offers sound, factual information on all ammunition components and shooting performance, and indicates how this information is applied to the choice of ammunition for hunting or target shooting. Want one?

THE NEW ENGLAND COUNCIL offers a free 48-page "Fisherman's Guide to New England," compiled and published by the editors of *National Sportsman & Hunting & Fishing Magazines*. For those who would angle this autumn in the fresh or salt waters of any of the six New England states, the Guide offers timely and complete information on good sections for inland fly and bait fishing, surf casting, deep sea game fishing, recommended lures and tackle, seasons, licenses, and other helpful data.

"PISTOL HIGHLIGHTS OF 1940" is Colt's Patent Firearms Manufacturing Company's answer to popular demand for a sequel to their last year's publication, "Spotting the 1939 Pistol Scores." In compiling this latest 40-page booklet, 65 of last year's most important pistol matches held in the United States and Hawaii were analyzed and have been indexed according to location. Replete with pictures of ranges and competitors—both winners and high tyros—it's a splendidly written resumé of 1940 handgun activities and will be royally welcomed by all pistoleers. Although the Colt people have been on an all-out defense program for months, they still find time to maintain their wide interest in civilian target work, as the new book indicates. Name and address, "pliz," and we'll send you one, free.

Copyright Richard E. Bishop

Use of a 16-mm. movie camera, geared up to operate at 128 frames per second, enables Richard E. Bishop, noted etcher of American game birds, to observe true details of ducks in flight, as in above etching

BOOK OF THE MOMENT is a 36-page publication, "Wild Ducks," by Col. H. P. Sheldon and Frederick C. Lincoln. Former is Chief of Division of Public Relations, United States Fish and Wildlife Service, and is nationally known for his knowledge of and articles on firearms and game conservation. Latter is one of our foremost authorities and writers on wildfowl and wild-bird migrations. Together, these men have now contributed a notable piece of work, delineating the history of wild ducks, their depletion and methods adopted to prevent it, and the results obtained. Publication contains 16 superlative pictures of as many species of wild ducks, reproduced in full, true-life colors from paintings by Fred Everett, noted illustrator, whose work has been described as "portraits rather than just pictures of birds and animals." Accompanying each of the five by six inch color plates is a concise, yet complete description of that species, together with outline map of North American continent on which, by means of shadings, are shown both breeding and winter ranges. All-in-all, a constructive contribution to our game program and an excellent reference book. Sells for 25 cents and in our opinion is the biggest quarter's worth we've seen in years. Copies may be obtained from the publisher, The American Wildlife Institute, 822 Investment Building, Washington, D. C.

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced."

SELDOM does the pupil stop to think that there must have been a time, long, long ago, when his teacher was himself only a lowly pupil, making the same timid beginnings and experiencing the same troubles that now perplex him. In case you have ever wondered how the preceptor and patron saint of the amateur telescope building hobby, Russell W. Porter, first took up telescope making, Figure 1 will place you at the exact original locus. It is true, this photograph was not taken at the original time—no such photograph now exists—but the surroundings are the exact ones in which Porter worked at Port Clyde, Maine, about the year 1909 when he was himself a rank beginner. The site is the cellar of his former home at the center of a 50-acre peninsula jutting into the Atlantic, about one third of the distance down—that, is, up—the Maine coast. The jug was surreptitiously slipped into the setting by the irrepressible Graves, of Los Angeles, who was present when the reminiscent photograph was taken, not long since.

How, in the first place, did Porter happen to become an amateur telescope maker? To understand this we must jump back 15 years farther, to 1894, when we discover him working his way through the Massachusetts Institute of Technology and studying architecture. One evening he heard Commander Peary lecture on the Arctic, and from that moment he was down with a bad attack of "arctic fever." He laid plans to get himself included in one of Peary's polar parties but was defeated through an unsuspected influence, though Peary had intended to include him: his mother secretly begged Peary to turn him down. Just then, along came a

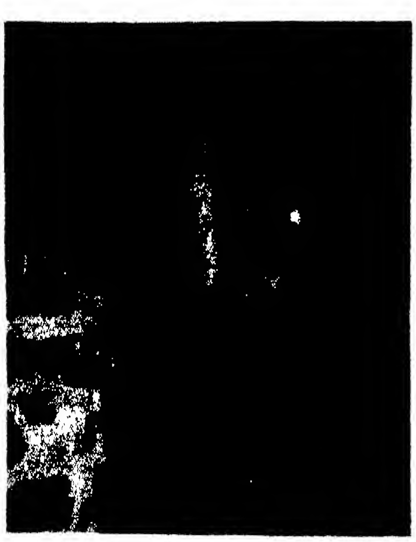


Figure 1: **Genesis**

Figure 2: **House at "Land's End"**

certain Doctor Cook, unknown but affable and entirely plausible. Yes, indeed, he was willing to accept the youthful Porter to go on an expedition to Greenland. Porter went, and the ship was wrecked and sunk (See Cook, "The Cruise of the Miranda.") In 1896, however, he went with Peary as far as Greenland. In '97 he led his own party to Baffinland. In '98 he started overland to the Klondike, reached the headwaters of the Peace River far up in British Columbia, but could get no farther by that difficult route. In 1900 he took a party to Greenland on Peary's ship. In 1901 he went to Franz Josef Land with the first Ziegler Expedition, and in 1903-4-5 he was with Fiala on the second, in the same high latitude. In 1906 he went to Alaska with Doctor Cook. The doctor had not yet been "shown

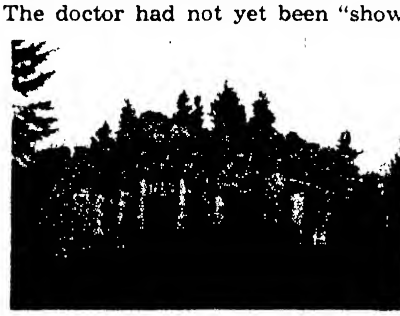


Figure 3: **Porter's Folly**

up" but, as almost any arctic explorer will tell you today, he was a personally lovable man despite his weaknesses. Cook announced a plan to ascent Mt. McKinley, highest on the continent, but also cooked up a plausible excuse to send Porter in another direction while he was ostensibly climbing the great mountain.

On all these expeditions Porter was not only the official artist and surveyor but the expedition astronomer. He picked up astronomy as he went along — the brilliant arctic skies aroused his interest.

By 1907, Porter's "arctic fever" had finally burned out and he married and settled down at Port Clyde, Maine. An old friend, Governor James Hartness, head of the Jones and Lamson Machine Company of Springfield, Vermont, Porter's real home town, sent him several copies of *Popular Astronomy.* In one of those he found an article by a man named Holcomb, of Decatur, Illinois, who described making a reflector. Through correspondence with Holcomb, Porter learned of the book, "Glass Working by Heat and Abrasion," by Paul Hasluck, now out of print. He set up the pedestal shown in Figure 1, made of wood sunk in the soil of the gloomy old cellar, and started work on a 10" disk. "I shudder even today," he recently commented, "when I recall its horrible figure." Encouragement for the tyro! Porter afterward made approximately 100 mirrors.

At the left, in Figure 1, is a stone pier having a ledge. Originally this

Figure 4: **Stained glass ship**

pier supported four fireplaces in the rooms above, but it proved to be squarely in Porter's way when, some time after his beginning, he wished to test a 16" mirror whose radius of curvature was 36'. The ledge represents the cut he therefore made in the pier, to enable him to make the test diagonally across the cellar. At another time, during Mrs. Porter's absence, when he wanted to try out a polar type refractor, he slashed a hole straight through the dining room wall of the house. She's still talking about it. Well, can you blame her?

Your scribe has visited this house and seen the cellar, in which various mirror-making accessories — glass tools, laps, and so on—remain, neatly arranged just as they were left about 25 years previous. They still remain. Figure 2 shows the house, built in 1819, and on it may be seen the small wing which Porter added as a study. Above this wing an unpainted vertical strip may be seen. Here the Porter polar telescope, shown in "A.T.M.," page 51, at V in Figure 42, once was attached.

Near the old house stands the fieldstone castle shown in Figure 3, built about 1910 by stonemason Porter, who wielded his own trowel.

Figure 4 is an interior view in this castle, showing Porter drawing heavily on a pet pipe. What looks like a picture of a ship is really a stained glass window showing the expedition ship *America* held fast in the ice near

Franz Josef Land in 1903, just before she was crushed and sunk there, leaving the explorers on half rations for two years. (See Fiala, "Fighting the Polar Ice," which contains a section by Porter). This window was made by Porter, of pieces of stained glass and lead "came."

Near the stone castle are the only remains of Porter's first observatory—a low circular stone wall on which, before it rotted down, stood a wooden fixed wall surmounted by a canvas dome.

If Porter hadn't heard Peary Lecture one night in 1894, he probably would have escaped his ten years of arctic fever, and thus his interest in astronomy. He therefore would not have wanted a telescope on his final return from the Arctic. The telescope making hobby would not have been expanded when it was; and so you, instead of making telescopes, might have been building bird houses for a hobby, or helping the ladies grow roses.

As Everest says, in "A.T.M.A.," a long stroke is scarcely sufficient for parabolizing a very short focus mirror, because after it reaches a certain depth it refuses to dig farther. Cyril G. Wates, Edmonton, Alberta, states that he therefore tried a star lap, as Everest recommends. "I cut a star in the middle of a disk of heavy cartridge paper, boiled this paper in paraffine wax, warmed up the lap and cold-pressed the paper disk into the lap, thus obtaining a star in relief. The result was good. This is essentially similar to Everest's method of pressing down facets with thin paper, but is more drastic.

When a mirror has a very short focal ratio, say from $f/2$ toward $f/0$ (properly described as a "greater" focal ratio, though the number used is smaller), it is doubtful whether much or any gain in time will be made in attempting to parabolize from the usual sphere. Recently we told here how Buchele, of Toledo, worked 14 hours to excavate a paraboloid from a 12" sphere of $f/2.4$. More recently, Ferson, of Biloxi, Miss., started out to parabolize a 12½" $f/1.4$ sphere by the ordinary method. Here r^2/R was more than one full inch. After 20 hours of perspiring he found he had gained only a quarter of this and leaned back to puff; and while puffing he suddenly decided to charge off the time thus far expended to experience and do the rest with Carbo.

He therefore gave it about three hours of No. 600 and then a little 303½ emery, and when the curve was approximately down to the desired point (as determined by giving it a brief polish, good enough to afford a rough knife-edge test), he did the regular full polishing and figured with pitch laps of 3", 6", and 12" diameter. In this latter sub-diameter tool technique there is a good deal in

common with working the correcting plate for a Schmidt.

STUNT for controlling fineness of rouge was described several years ago in a letter from C. A. Spickler, Yardley, Pa. He siphoned the rouge water from a bowl into a tea cup placed at a lower level, using a strip of woolen cloth. The fineness of the rouge deposited in the cup is regulated, he states, by the quality of the cloth. This may be the answer to some workers' trials with scratchy rouge.

CONSERVATIONIST James G. Hayden, New Lexington, Ohio, urges others who are hard up to follow his example. With a "biscuit cutter," or rotating metal ring armed with abrasive, driven by a motor, he cut up two old glass tools of 6" and 10" diameter into two 4¾" and two 3¾" mirror disks and now has four extra mirrors where none grew before. Of course, if you count your time—but don't count your time.

FOR the benefit of non-mathematical readers, Ellison, in his treatise on the objective lens, according to Royal W. Woodring, of Woodring and Mattie, masons, 202 Highland St., Roxbury, Mass., "explains the meaning of the term reciprocal, goes into his 'rule of three,' and, in general, does a lot of hopping and skipping around to confuse the reader. I have reduced his equations to order."

We can't admit that Ellison's equations are confusing, though the Ellison presentation probably would strike some who do not need such help as containing much that is superfluous. Anyway, for those who have already mastered Ellison and Haviland on the objective lens, the compact framework offered by Woodring undoubtedly will be a big help. It is as follows:

First Curve

Crown lens: Radii of surfaces as 2: 3.

Flint lens: One surface fits one surface of crown. The other is plane (or very nearly so).

(Decide on the focal length you want for completed objective and call it F).

$$r_1 = \frac{5\,F\,(\text{cr}\,u - 1)\,(\text{cr}\,V - \text{fl}\,V)}{3\,(\text{cr}\,V)}$$

= number corresponding to $[0.22185 + \log F + \log (\text{cr}\,u - 1) + \log (\text{cr}\,V - \text{fl}\,V) - \log (\text{cr}\,V)]$

$$r_2 = \frac{3}{2} r_1$$

$$r_3 = r_2$$

$$r_4 = \frac{5\,F\,(\text{cr}\,u - 1)\,(\text{fl}\,u - 1)\,(\text{cr}\,V - \text{fl}\,V)}{5\,(\text{fl}\,V)\,(\text{cr}\,u - 1) - 2\,(\text{cr}\,V)\,(\text{fl}\,u - 1)}$$

= number corresponding to $[0.69897 + \log F + \log (\text{cr}\,u - 1) + \log (\text{fl}\,u - 1) + \log (\text{cr}\,V - \text{fl}\,V) - \log \overline{5\,(\text{fl}\,V)\,(\text{cr}\,u - 1) - 2\,(\text{cr}\,V)\,(\text{fl}\,u - 1)}]$

[Formula for r_4, above, being too long for the column, its numerator and denominator are each broken in two pieces. Similarly with single term under vinculum, above.]

Second Curve

Crown lens: Radii of surfaces as 3: 2.

Flint lens: One surface fits one surface of crown. The other is plane (or very nearly so)

$$r_1 = \frac{5\,F\,(\text{cr}\,u - 1)\,(\text{cr}\,V - \text{fl}\,V)}{2\,(\text{cr}\,V)}$$

= number corresponding to $[0.39794 + \log F + \log (\text{cr}\,u - 1) + \log (\text{cr}\,V - \text{fl}\,V) - \log (\text{cr}\,V)]$

$$r_2 = \frac{2}{3} r_1$$

$$r_3 = r_2$$

$$r_4 = \frac{5\,F\,(\text{cr}\,u - 1)\,(\text{fl}\,u - 1)\,(\text{cr}\,V - \text{fl}\,V)}{5\,(\text{fl}\,V)\,(\text{cr}\,u - 1) - 3\,(\text{cr}\,V)\,(\text{fl}\,u - 1)}$$

= number corresponding to $[0.69897 + \log F + \log (\text{cr}\,u - 1) + \log (\text{fl}\,u - 1) + \log (\text{cr}\,V - \text{fl}\,V) - \log \overline{5\,(\text{fl}\,V)\,(\text{cr}\,u - 1) - 3\,(\text{cr}\,V)\,(\text{fl}\,u - 1)}]$

Third Curve

Crown lens an equi-convex.

Flint lens plano-concave. Its concave surface has the same radius as either surface of the crown.

$$r_1 = \frac{2\,F\,(\text{cr}\,u - 1)\,(\text{cr}\,V - \text{fl}\,V)}{\text{cr}\,V}$$

= number corresponding to $[0.30103 + \log F + \log (\text{cr}\,u - 1) + \log (\text{cr}\,V - \text{fl}\,V) - \log (\text{cr}\,V)]$

$$r_2 = r_1$$

$$r_3 = r_2$$

$$r_4 = \frac{2\,F\,(\text{cr}\,u - 1)\,(\text{fl}\,u - 1)\,(\text{cr}\,V - \text{fl}\,V)}{2\,(\text{fl}\,V)\,(\text{cr}\,u - 1) - (\text{cr}\,V)\,(\text{fl}\,u - 1)}$$

= number corresponding to $[0.30103 + \log F + \log (\text{cr}\,u - 1) + \log (\text{fl}\,u - 1) + \log (\text{cr}\,V - \text{fl}\,V) - \log \overline{2\,(\text{fl}\,V)\,(\text{cr}\,u - 1) - (\text{cr}\,V)\,(\text{fl}\,u - 1)}]$

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A DICTIONARY OF RADIO TERMS is a 36-page illustrated booklet, brought up to the minute by the inclusion of terms developed to describe the very latest in radio equipment and technique. Over 800 radio terms and abbreviations are included. *Allied Radio Corporation, 833 West Jackson Boulevard, Chicago, Illinois.—10 cents.*

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SMASH THE BOTTLENECKS is an eight-page brochure which tells of the work which trucks are doing and can do in the transportation scheme of the United States, if certain laws which are apparently unfair to the trucking industry can be amended. *American Trucking Associations, 1424 16th Street, N. W., Washington, D. C.—Gratis.*

ACCURACY OF ENGINE LATHES outlines a series of 25 tests to be applied in checking engine lathes for accuracy under standards which have already proved their value in practice. Request bulletin B5.16-1941. *American Standards Association, 29 West 39th Street, New York City.—25 cents.*

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AMERICAN WHEELABRATOR DIGEST is a 12-page house organ devoted to the advancement of better metal cleaning methods for use in industry. *The American Foundry Equipment Company, Mishawaka, Indiana. —Gratis.*

WHY DEMOCRACY? presents the text of an address by C. Donald Dallas in which were outlined responsibilities that fall upon everyone in the process of making democracy work. *Revere Copper and Brass, Inc., 230 Park Avenue, New York, New York.—Gratis.*

KNU-VISE TOGGLE-ACTION CLAMPING FIXTURES is a 24-page catalog which illustrates and describes the uses of 22 different models of clamps, pliers, riveters, and drill fixtures, largely for industrial purposes. *Knu-Vise, Inc., 16841 Hamilton Avenue, Detroit, Michigan.—Gratis.*

A SHORT STORY ON SHORT-WAVE RADIO RECEIVERS is a 12-page illustrated booklet for those who desire to obtain the most dependable reception from foreign short-wave broadcasting stations. *The Hallicrafters, Inc., 2611 Indiana Avenue, Chicago, Illinois.—Gratis.*

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Printed in the U. S. A. Press of the Wilson H. Lee Company, Orange, Connecticut.

CLOSELY linked with real or imaginary gasoline shortages in many parts of the country is the fundamental problem of transportation, little known and little understood. Clarification of this factor, essential to an understanding of fuel availability, is presented in the article starting on page 251. Our cover illustration shows an oil tanker taking on its cargo.

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SCIENTIFIC AMERICAN

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NINETY-SEVENTH YEAR • ORSON D. MUNN, Editor

NOVEMBER • 1941

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WHAT TO DO ABOUT ASTROLOGY?

ASTRONOMICAL circles—particularly the 70 local groups and clubs of amateur astronomers on this continent—have recently been greatly exercised because a Hollywood motion picture producer is preparing to release a series of 12 films on astrology. They are fighting it.

This, we believe, will be the first large-scale incursion of astrology into the motion picture audience. Astrology's following already is immense, running, we are told, into the millions.

We have added our protests to those already made, simply writing to Mr. Will Hays, motion picture "czar" at Hollywood, that we wish to go on record as stating that scientists stand solidly against the pseudo-science of astrology—which, of course, is a fact.

It would serve little purpose here to try to refute astrology, since we can assume that our readers already oppose it—though each time we have mentioned it in this magazine without much respect, we have, it is true, received letters of protest, but never more than a trifling few. The question is, rather, what can Scientific American readers do to fight astrology in other circles where it is accepted.

For years we have given this matter much thought, but no real answer has appeared. It is easy to refute astrology—for those who already regard it as a pseudo-science; but it is not easy to refute it for those who want to believe in it. In fact we feel that, in the main, no direct attack on astrology is likely at all to have more than limited effect until the general standard of education has been raised—a long, slow process. When that has been done there will automatically be little need to refute astrology.

Two notable attempts in the direction of refutation have been made in recent years, one a rather intellectual paper by Dr. Bart J. Bok and Margaret W. Mayall, astronomers at the Harvard College Observatory, and the other a rather practical if not hard-boiled approach made a year or so ago by our contemporary, *Good Housekeeping,* which probably reaches far more who believe in astrology than does Scientific American. *Good Housekeeping* put the astrologers in a truly awful predicament—and then did nothing to save their faces. It offered to place four astrologers, selected by other astrologers, in separate rooms where they were each to cast the horoscopes of two persons to be selected by its editors. It also agreed in advance to publish the findings, regardless of their outcome. That challenge was not accepted—proving that the astrologers are not fools at all, whatever else they may be!

It is probably not correct, however, and it certainly is not good psychology, if one wishes to shake their beliefs, to label the astrologers fakes and frauds, as some have. Individual frauds there undoubtedly have been, and are, within astrological circles, but in the main the astrologers are honest people who sincerely believe what they believe, and are a bit hurt, in fact, because the scientists treat them somewhat roughly. They are also puzzled because science seems so stupidly blind to the obvious truths they claim to possess. Bigotry and intolerance, this attitude from our side appears to them—and, to tell the truth, some of us really have been bigoted and perhaps intolerant toward astrology. We need to cultivate more patience. Most of these people who accept astrology have had no background in the scientific world, and therefore have no way of seeing the difference between science and pseudo-science; to them, each looks about alike. Moreover, the fact is, and we should admit it, that, even within our world of science, there is not and never has been any way to distinguish positively between truth and error—all such things must be considered as relative.

If one merely wishes to have some fun, and to start a believer in astrology off on an hour's sputtering and raving, just call astrology a fraud and a fake. But if the desire is genuinely to alter his state of mind, that sort of approach is only certain to fix it. Arguing with the typical astrologer is not likely to prove very satisfying. You find that his arguments are not so much rational as emotional. And he is shifty—though we do not necessarily mean dishonest. Once, when a group of amateur astronomers in one of our larger cities was preparing to put on a public debate for and against astrology, we warned its officials that they would not get very far. They wrote afterward thus: "Reasoning with the astrologers proved to be just like punching a feather pillow—you sock it in one place and it bobs up in another. You had them figured out to a tee, and everything you promised for us came true. They haggled about definitions. So we got nowhere."

Haggled about definitions—here is the chief rub, but it's something which few except trained logicians understand as sharply as they should. In any argument, of any kind, unless the two sides accept *at least the premises in common,* there has been no real meeting of minds—no real argument. The astrologers argue from a different set of premises than do the astronomers. Probably there is, therefore, little that can be done about it, until we succeed in reaching the general standard of education mentioned a few paragraphs back.

The fact is that, on the whole, there probably is little that can be done about astrology; probably we on the scientific side haven't yet come fully to realize this fact. We tend to think that, in some way or other, a way can be discovered, if we try hard, to knock the astrology out of those who believe in it. It appears that this, like astrology itself, is mainly a delusion. It probably will take centuries, millenia, to rationalize humanity to the extent necessary to do away with astrology and equally unscientific beliefs.

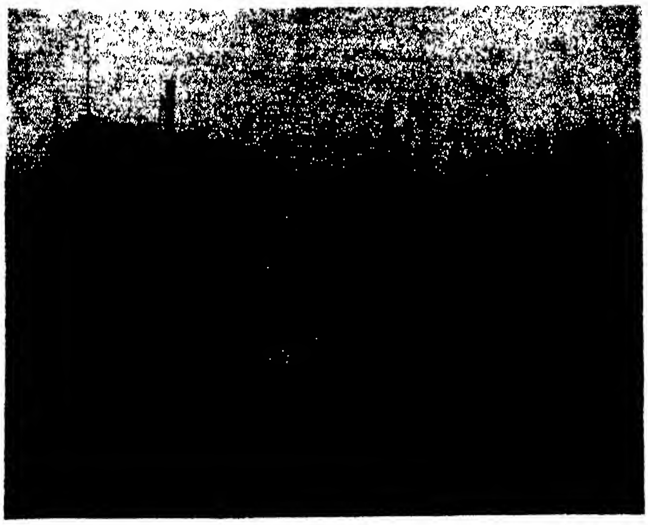
Nevertheless, all protests against the aforementioned films, sent to Mr. Will Hays, Hollywood, California, should carry due weight in the immediate circumstances and perhaps help to prevent further exploitation of the gullible.—*A. G. I.*

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of November, 1891)

DRY DOCK—"Almost a year has been required in the work of constructing the recently completed dock shown in our illustration, at the foot of Orleans Street, Detroit, Mich. . . The soil where the dock is built is of fine blue clay, so that there was no interruption to the progress of the work from land slides or leakage. Two thousand piles were driven, making the structure very strong, it being designed to safely dock loaded ships carrying a cargo of



3,000 tons, while taking in vessels of the largest size. . . The pumping plant consists of two centrifugal pumps, with 30 inch discharge each, driven by two 150 horse power independent compound Westinghouse engines. . . This dock is large enough to take in any boat now upon the great lakes, and has been designed especially for the wide railway car ferries and passenger boats with their overhanging guards and paddle-wheels. The cost of the dock was upward of $200,000."

SNAKE—"The hoop snake does not roll and does not take its tail in its mouth. It progresses by loop movements, somewhat like the measuring worm. The snake gathers itself up into large loops, and pushes itself forward, all with such amazing rapidity as to appear, to a frightened beholder, as if it actually rolled."

OVER-EXERCISE—"Those who believe in the necessity of physical exercise have need also to remember that even so good a thing as this is in excess an evil. The use of the cycle is a form of bodily recreation in itself doubtless wholesome; none the less it is open to the mischievous effects of undue indulgence. . . Whenever prostration beyond mere transient fatigue follows the exercise, or when digestion suffers and weight is markedly lessened, and a pastime which ought to exhilarate becomes an anxious labor, we may be sure that it is being overdone."

LIGHTNING RODS—"Dr. Hess, who has been collecting statistics and has examined the tips of many lightning rods, finds that fusion of the points never occurs. A fine, smooth point receives the lightning in a concentrated form, while angled or ribbed, as well as blunt points, divide it into threads. Dr. Hess considers that platinum needles and tips are entirely unnecessary, for they have no advantage over copper points; but as there are lightning strokes which are capable of making wire 0.20 in. thick incandescent, unbranched copper conductors should never be of less diameter than this, though in a good lightning rod the main point is to secure perfect communication between it and the earth."

MORTALITY—"It is true that we have immensely lessened infant mortality and extended the mean duration of life to over forty-five years. But the average number of old people is not correspondingly increased, and it is even charged that when great old age is now reached, it is abnormal."

COMPARATIVE COST—"At the recent meeting of the American Street Railway Association, Mr. Pearson, of Boston, said his road has about 350 cars equipped with electric motors. The expense of operation with horses is about 25 cents per car mile. . . The cost of operation with electric motors up to the present has been 20 cents per car mile."

RIFLE—"The new Italian rifle is of 6.5 millimeters caliber. The most important factor in connection with the rifle is the smokeless powder cartridge, which, owing to its light weight and small size, permits the number of cartridges carried by the soldier to be augmented to 160. . . Loading is effected by means of magazines containing five cartridges so arranged that a repeating fire may be maintained until the magazine is exhausted. Experts are convinced that the weapon is the best and most destructive at present existing among European armies."

SPONGES—"The sponge fisheries of the Bahamas cover a large extent of territory, give employment to about six thousand men and boys, and are a source of revenue to the colony larger than any other industry pursued there. . . The quantity shipped from these islands during the year 1890 was 623,317 pounds, the local value of which amounted to $34,500."

EGYPTIAN—"Three colossal statues, ten feet high, of rose granite, have just been found at Aboukir, Egypt, a few feet below the surface. The discovery was made from indications furnished to the government by a local investigator, Daninos Pasha. The first two represent in one group Rameses II and Queen Hentmara seated on the same throne. This is unique among Egyptian statues. The third statue represents Rameses standing upright in military attire, a scepter in his hand and a crown upon his head. Both bear hieroglyphic inscriptions."

NOW X-RAYS CAN—"The bursting of the 68-ton fly wheel of the great engine in the Amoskeag mills, Manchester, N. H., furnishes additional evidence, if such were needed, to prove that with the means now at hand the possibility of flaws in large castings cannot be determined with certainty. . . Till means are found to discover flaws in segments for large fly wheels, it is not safe to use them in the vicinity of workrooms, as at Manchester."

DUST EXPLOSIONS—"Two accidents due to the explosion of coal dust afford further proof of the well-known fact that coal dust is itself a dangerous explosive."

Personalities in Industry

FOWLER McCORMICK

NEW PRESIDENT of International Harvester Company, Fowler McCormick is the fourth of his family to head the business founded by his grandfather, Cyrus Hall McCormick, inventor of the reaper. The McCormick stockholdings and the McCormick tradition of personal participation in the business, taken together, would doubtless have assured Fowler a job and a title. But there is great question whether those things alone could ever have made him president. The "corner office" at Harvester is no spot for a dilettante. The man who occupies that office now, at the relatively early age of 42, is a hard-working, practical executive with no taint of the dabbler about him.

He works hard, associates say, because he is temperamentally unable to take a half-swing at anything. He is practical because of intimate personal contact with the men in the shop and the farmers in the field.

Born in Chicago, McCormick was educated at Groton School and at Princeton University, from which he was graduated with the class of 1921. When he decided that what he wanted to do was to work for the Harvester Company—and the decision was not automatic—he began as a laborer in the Milwaukee Works. Since that time he has been a part of nearly every phase of the business.

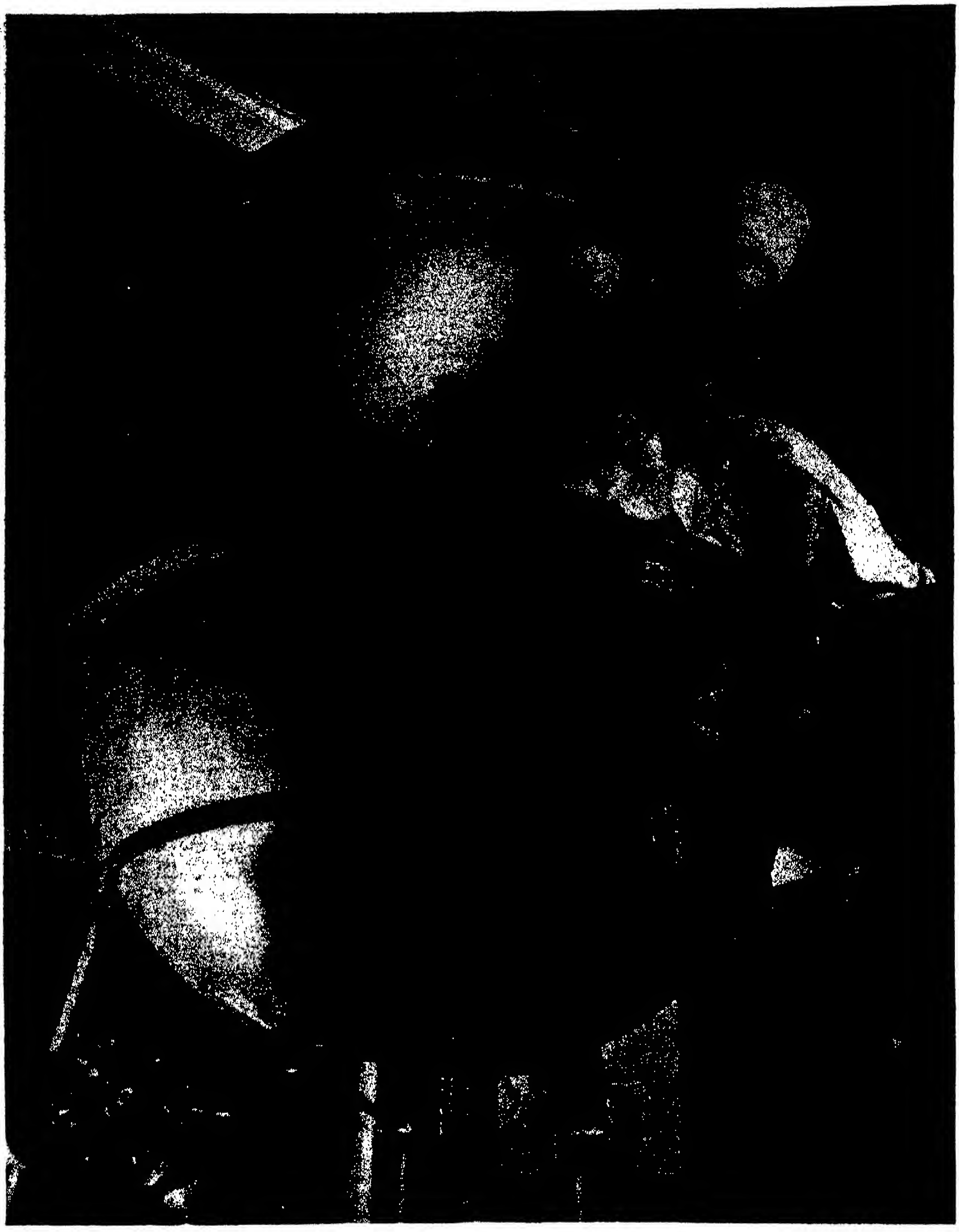
The man who has been shaped by the impacts of these various experiences is serious without being stodgy. He has avoided the pitfalls of personal hauteur and mock modesty. The outstanding impression he creates in the minds of new acquaintances is one of sincerity; he seems always to be thinking of what you are saying or what he is saying—never of what impression he may be making.

Mr. McCormick has evolved a personal business philosophy. He regards his company as primarily a social institution which must justify its continued existence by social usefulness. He conceives that it has an immediate responsibility to three major groups: its customers, its employees, and its stockholders. The job of management, in the McCormick scheme of things, is to provide for each of those groups the greatest benefits commensurate with the rights of the other two.

This responsibility has led Mr. McCormick, among other places, into a deep and continuing interest in the company's industrial relations problems. He is neither sentimental nor hard-boiled about this. He evidently wants employees to feel that they would rather work for Harvester than anywhere else, but he has no desire to pose as a generous lord of the manor. Furthermore, having assured himself that the company's wage and other policies are right, he will not be pushed around, a fact discovered early this year by a number of union leaders. He genuinely believes in collective bargaining but he has no notion that collective bargaining means saying "Yes" to every demand, reasonable or unreasonable.

His approach to most problems is that of the student. He gathers and assimilates quantities of facts and opinions before acting. His patience during this process is monumental. No one can remember that he ever snapped at a bore or a ditherer.

Outside the office, Mr. McCormick lives quietly. He seldom talks about himself or his activities. He has a farm near Barrington, Illinois. He is known to be a musician and a student of psychology. There is a current rumor that he is learning to fly. His golf, at best, is mediocre.



TREATING GLASS TO ELIMINATE GLARE

In a new method for treating glass surfaces to eliminate glare and increase the efficiency of many optical instruments, the units to be treated are placed in a large metal globe which is then sealed and evacuated. When a bit of magnesium fluoride is electrically evaporated in the vacuum, the vapor coats each glass surface with a film 1/300,000 of an inch thick. Photograph shows the equipment developed for this work in the research laboratories of the General Electric Company. The glass units, in metal frames, are held to the interior of the sphere by alnico magnets.

97TH YEAR SCIENTIFIC AMERICAN NOVEMBER 1941

BOMBERS TO BRITAIN

Gigantic Newfoundland Airport is Jumping-Off Place

EDWIN MULLER

NATIONAL DEFENSE

THERE'S a spot in the windy wastes of Newfoundland the name of which is known to very few, but it's one of the most important and exciting places in the world. Yesterday an uninhabited waste of spruce forest and muskeg swamp, it is today the world's biggest airport—and growing bigger as fast as thousands of men working day and night can make it. It swarms with aerial traffic. The scores of bombers that arrive and take off for Britain every week are only one of its activities. It's the great junction and forwarding point for transatlantic passengers and air-borne freight. It's the center of military flying the nature of which cannot be fully told. It is, perhaps, the most vital point in the outer defenses of this hemisphere.

For an hour before I arrived there, in a Lockheed-Hudson bomber, I had been sweating steadily on the palms of my hands and the soles of my feet. After sighting Newfoundland, coming in high and fast over the blue, empty waters of the Gulf of St. Lawrence, we had run into a solid bank of fog—like ramming your head into a wall. For 200 miles we had just two fleeting glimpses of land.

By now we should be over the airport. The pilot couldn't be sure because, for various reasons, there is no radio beam at the airport. We made one or two tentative dips down through the gray soup. No land. Then we turned tail and ran north toward the ocean to get our bearings, coming out suddenly into the clear. Back we went toward the airport, keeping just under the ceiling. At a scant 400 feet it seemed as if we'd scrape our bottom on the tops of the pine trees. I was glad to land.

Coming onto the field by air you are bewildered by its immensity. Seemingly, you could set down La Guardia or Tempelhof in one corner and then have to hunt for it. Runways are so big that an ordinary plane could land or take off across their width. The expanse is like a smooth lake, so wide that when you strain your eyes across it, you see a mirage against the far horizon.

I tried once to count the hangars and shops, but it's half a day's brisk walk to skirt the edge of the runways and by the time I'd gotten around I'd lost count. And here and there in the distance the skeletons of other hangars are rising, and sprawling villages of houses, and sheds, and barracks, and tents.

Switch engines shift long strings of box cars from which are unloaded mounting piles of lumber and steel, crates and drums. Bulldozers scrape off the forest growth, acres at a time, and steam shovels scoop out great pits in the raw earth. Riveting machines are going on every side. Fleets of trucks and tractors are busy. Every now and then a blast goes off and you see a geyser of smoke and chunks of rock thrown high in the air. The noise goes on by night as well as by day.

Above all is the constant overtone of airplane motors tuning up. Most thrilling is the breath-catching crescendo of a big bomber as it starts down the runway on the long, lonely road to Britain.

That night I met some of the men who fly the big ships across. For several days bad weather had been reported from "Q. M.," the secret and well-guarded airport in the United Kingdom where the bombers land, and more than a score of fliers were waiting at the Newfoundland field, sitting around the rough board tables of East-Bound Inn.

These are not the dare-devil youngsters who fly the ships in combat over Europe. There are plenty of gray hairs, and every pilot has had thousands of flying hours. Some flew in the last war. They have come from trans-continental lines in the United States, from Imperial Airways, in Britain, from Trans-Canada Air Lines. You hear tales of the early days of the Southampton to Singapore run, of being forced down in the desert and hiding in the dunes from tribesmen until rescued; of landing mountaineering parties on inaccessible glaciers of Alaska, keeping them supplied by parachute; of ferrying freight into the jungles of the Amazon.

ON THIS transatlantic job the pilots have settled down to routine. It takes nine to ten hours to cross and, when the weather is good, they maintain a schedule as regular as that of ferry boats crossing the Hudson. Each pilot is given a flight-plan, telling him his course, what height to reach at each point, what weather to expect and how to dodge it.

The weather man is really the pilots' hero at this airport. They say there has never been anything like his work. "He tells you: 'In

Official photograph, U. S. Army Air Corps

A Consolidated B-24; in England these ships are called "Liberators"

Zone 5 at 6 o'clock there will be ceiling at 2000 feet, top of cloud at 6000, moderate icing at 5000, tail wind of 40 miles per hour, veering shortly to north.' You get there and that's exactly what it is."

Sometimes the pilots fly the course at 15,000 feet, or higher, the whole way over. It's 50 degrees below zero up there but the heated planes are comfortable. Insidious, though, is the effect of altitude: at first you don't recognize the dreamy, don't-care feeling as the higher centers of the brain gradually cease functioning and you may wait too long before attaching the oxygen tube.

One pilot, flying in winter at 20,000 feet to avoid icing, had to detach his tube and go back to help a passenger. When he returned to his seat he had to readjust his tube, a simple operation. But he couldn't do it. The tube in his hand approached the socket—wavered away. That went on for five minutes while they slipped down toward the dangerous icing level. Then the navigator realized what was wrong and came to the rescue.

They don't see much of the ocean. Most of the flight is above a vast sea of unbroken cloud from horizon to horizon, an Arctic landscape of white hills and valleys. On its surface, far below, the tiny black shadow of the plane drives along.

Sometimes that glacial surface is torn apart. Then they may see a big convoy crawling along, destroyers circling its flanks. One pilot saw the last plunge of a torpedoed merchantman, the stern rearing high. Men were struggling in the water—no life boats. There was nothing the pilot could do.

In the last hours they begin to slide down toward the landfall, a faint, dark smudge on the horizon. There the pilot and his crew search the skies for intercepting Germans. Not so anxiously now, however, as at first. In all the hundreds of crossings only one or two pilots have sighted a German—and nothing came of it. Once a Hudson sighted a Fokker-Wolf. Both turned tail and ran.

The landing at Q. M. is made on a field so ingeniously camouflaged that even the keenest-eyed German observer could hardly recognize it as an airdrome. It doesn't look like a spot where you could make even an emergency landing. There's no fuss about the arrival. Three years ago the surrounding countryside would have been black with the crowds waiting to greet a transatlantic flier. Now, when the pilot and his crew crawl out of the fuselage, they are greeted casually, pick up their suitcases and trudge away to quarters. They may get a few days leave—London if they're lucky. Or, within 12 hours, they may be on their way back by ferry plane.

The pay is high—a minimum of $1000 a month, with a bonus for each trip above two trips a month. A pilot may earn better than $25,000 in a year. Navigators and radio operators earn about two-thirds of a pilot's pay.

Nothing irritates these fliers so much as the suggestion that they are engaged in a glamorous, adventurous job. They deny it, with profanity and short, Anglo-Saxon words. It's a routine flying operation, they assert, and rather dull at that. One of them is saving his pay to open a haberdashery store in Seattle. He looks forward to that. They read detective stories, one after the other to keep from being bored. They say that the R.A.F. puts a combat pilot on the transatlantic run to rest him.

They really mean it—but it isn't so. Two thousand miles of empty ocean isn't a routine flying job—not yet. No plane, so far, has come down on the water but that record can't be maintained indefinitely. The worst hazard is on the take-off, when the plane has to get off the ground with its staggering load of extra gasoline.

One night at East-Bound Inn a pilot came in with the news that a returning ferry plane had cracked up on the take-off at Q. M. The 22 men in it had been killed. Every man present had good friends on that plane; some of those killed had sat at this same table two nights before. The talk stopped a few seconds, then resumed. The conversation was of other things.

Accidents never interrupt the eastern flow of traffic. I was in the control tower watching a line of Hudson bombers take off for Britain, one every five minutes. It was the turn of the fifth in line. It started for the take-off—got half-way up the runway. Suddenly it swerved slightly, then a violent swing, and it came around in a three-quarter circle of a ground loop. The under-carriage collapsed and one wing sagged to the ground. It couldn't have been two seconds before it blazed up, a great bloom of orange flame. Three little figures dived out through the door in the tail.

With the scream of the siren the fire trucks were out on the field. But, while the flames were still burning brightly, two tractors raced out, yanked the big plane off the runway, drew it to one side. Ten minutes from the time of the accident the next bomber in line had taken off and was on its way.

Across the broad runways from East-Bound Inn are the quarters of the Royal Canadian Air Force. It

is forbidden to go into detail on the activities of the R.C.A.F.—the technique which it has evolved for protecting convoys, the broad net which it has flung over the western ocean. It's no secret, however, that there are planes today which are capable of flying to Germany from Newfoundland, delivering a load of bombs, and returning.

Here as nowhere else you can see how fast space and time are shrinking. You see the big transport planes come in, the Consolidated B-24's, as large as the ships in which Columbus came over the sea. They converge from points on the American continent, stop to check and refuel, wing on across the ocean. An official in Washington must make a quick trip to London. Via this Newfoundland airport he can be there within 24 hours. At your breakfast table here you can choose between *The New York Times* and the London *Times* of the day before. It's all as casual as travel between New York and Chicago.

This air center is a shipping point for freight as well as passengers. All kinds of non-bulky goods are carried—urgently needed airplane parts, vitamin concentrates, precision instruments, laboratory materials. One plane carried to Britain a shipment of 200 bullfrogs consigned to a laboratory engaged in the study of the effects of poison gas. They disturbed the pilot by croaking loudly all the way over.

It's a bleak, inhospitable spot, this Newfoundland airport—long, icy winters, snow that falls through June and starts again in September, piling up in 20-foot drifts on the lee side of the runways. Always the wind blows, in gales and gusty squalls. Fog lies heavy.

No trees are left standing in the settlement, there's no blade of grass. The houses and shacks are hammered together from rough timber. The unpaved streets are deep in sticky mud. Everywhere there is mud. The clear brooks have turned to sluggish streams of liquid mud. There are scores of gun emplacements, camouflaged pits where the anti-aircraft guns thrust muzzles toward the sky. You can't walk far without being challenged by sentries.

The bulk of the construction gangs are "Newfie" laborers from St. Johns or the coastal fishing villages. There are the superintendents and foremen, the mechanics and engineers, the troops who garrison the post, the Newfoundland Rangers who police it. Beer, when it's to be had, is drunk out of the bottle.

Official photograph, 2d Air Base Squadron Photo Section

Sister ships of this Flying Fortress are seeing service abroad

Feminine influence is lacking. There are a few wives of the construction superintendents and half a dozen nurses in the hospital, but they are not much on view. There is also the daughter of the base manager, Sally Elizabeth Ross, who is almost seven and easily the best known and most popular resident.

But in general it's a he-man place, lacking the amenities.

And yet there are few spots on earth where more big names are registered. A Walter Winchell would have a busy life here. In the short time I was there Lord Beaverbrook and Lord Halifax, a Roosevelt and a Royal Duke were seen about the East-Bound Inn. Lady Halifax and Harry Hopkins had been through a few days before.

When the war is over, some airmen say, this will be the center—the chief junction and forwarding point—for transatlantic traffic. There are some who doubt it. These latter say that the fogs of Newfoundland will always limit its use to aviation, also that the long-range planes of the future won't need a half-way point. But, no matter how long a range planes may have, they will carry a bigger pay load across the Atlantic if they stop to refuel a third of the way over. Bermuda and the Azores will be used too, but this northern route is the shortest path between the important centers of North America and those of Europe.

It will be a different place then. There'll be warehouses for freight, big hotels for passengers. East-Bound Inn will be an affair of 1000 rooms, 1000 baths, and will probably preserve as a show place the present room where the pilots gather. The mud will disappear, the raw earth will be landscaped and beautified. There'll be schoolteachers from Nashville and bank clerks from Cleveland on their way to Europe for a two-week vacation, business men from Chicago and from Prague, students from Tokyo and Harvard and Vienna. This will be the most cosmopolitan spot on earth, where all nationalities will meet and pass.

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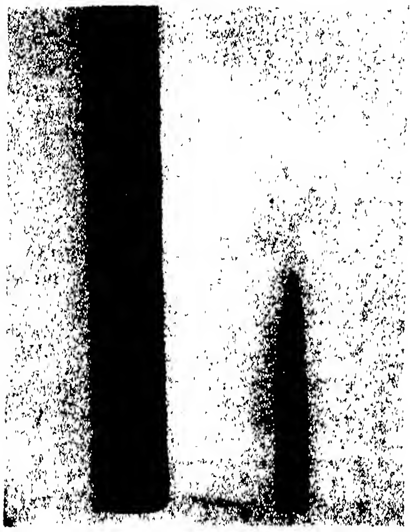
BULLET-SEALING

Hose Protects Fuel System of Combat Planes

Self-sealing fuel tanks for military airplanes can now be supplemented by self-sealing hoses, thus providing a completely protected fuel system. This new bullet-

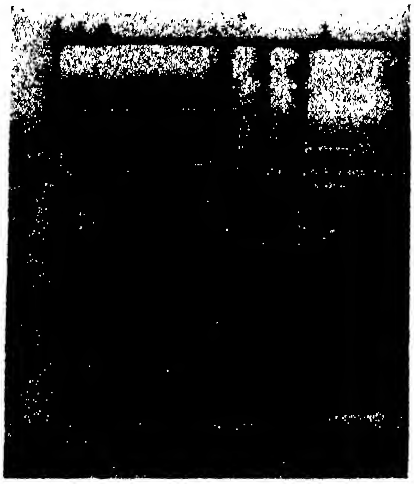
sealing hose was recently announced by The B. F. Goodrich Company.

The secret of the hose construction is a sealing member that prevents fuel leaks even under ten to fifteen pounds pressure and despite numerous punctures from large-caliber machine gun bullets. The inner surface of the hose is a layer of Ameripol, the synthetic



rubber which is highly resistant to oil and gasoline.

The principal use of the hose in aircraft is to connect fuel tank cells and engine supercharger systems. With this hose, it is stated, there will be a substantial saving in weight in the average bomber; the rubber hose eliminates the weight of auxiliary metal fuel systems which are ordinarily required to guard against the hazard of punctures in main fuel lines.



Above: **Testing bullet - sealing hose with .50-caliber machine gun.** ***Left:*** **Despite holes, hose held fuel at 10-15 pounds pressure**

BLACKOUTS?

Value Questioned by Lighting Expert

STREET lights are silent policemen on the night force of every police department, Dudley M. Diggs, a General Electric engineer, recently told the International Association of Chiefs of Police.

Any reduction in these lights during the present emergency would result in increased crime and traffic accidents, he said, citing a number of cases to prove that the criminal element takes advantage of the darkness, which also imposes an additional handicap on the automobile driver. Diggs urged the use of modern lighting systems to meet modern traffic needs, and said that blinding lights directed skyward to confuse and mislead enemy airplane pilots may be found to afford better protection for cities than the blackout in case of war.

Diggs doubted that blackouts would ever be needed for American cities, and pointed out that the blackout in countries abroad has been of questionable value as a military measure while creating many new problems for officials to solve. Nazi fliers, he said, can find English cities via radio beams, and are aided by the breaking surf on the coastline, plus the reflections from roof tops and from rivers. In modern war, parachute flares and incendiary bombs can easily pierce the blackout, Diggs explained. The work of the police, air-raid precaution workers and firemen is hindered during blackouts, he said while traffic accidents occur much more frequently and the morale of the people is attacked through reduction in social life. Transportation is slowed, as well as loading and unloading of important war and other materials in the darkness, it was explained.

The use of small though powerful searchlights and wide angle floodlights directed skyward to confuse and hinder the enemy would also aid protecting aircraft in shooting down the enemy, and would allow civilians to live and work under more normal conditions, Diggs said. In preliminary tests of the plan, the U. S. Army has been reported to have found that even with a long viewing tube airplane pilots could not penetrate the glare to find important targets, thus indicating the effectiveness of the "reverse blackout," the engineer added.

ANTI-BOMBER

New Gun for Defense Against Dive Bombers

A WICKEDLY efficient 20 millimeter machine gun of tremendous fire power, now being produced in quantities, is said by experts to be the answer to the dive bomber menace for ships at sea.

While no details have been released regarding this particular weapon, one of our accompanying illustrations shows a completed production model as built by the Hudson Motor Car Company. Similar weapons are being produced by the Pontiac Motor Division of General Motors.

Reportedly a potential Nemesis for Stukas

Oil Is Where You Ship It

Transportation Facilities Available to the Petroleum Industry Govern Fuel Supplies

A. P. PECK

REGARDLESS of what may be the precise gasoline and fuel-oil situation in any particular part of the United States by the time this article reaches the reader, there are certain facts that consumers of petroleum products are entitled to know; lacking these facts it is almost impossible to evaluate the rapidly changing picture as presented in the daily press.

The beginnings of the gasoline and fuel-oil shortage on the eastern coast of the United States are now history. Developments at the time of writing are coming so thick and fast that it is still anyone's guess as to the ultimate outcome. Thus it seems appropriate to forget for the moment the day-by-day reports from the gasoline and fuel-oil battle-front and to dig into the service of supply in an endeavor to bring into clear focus those problems of the oil industry which must be solved and constantly re-solved in order that fuel supplies of all types may be assured to the entire nation.

It has been frequently stated elsewhere, but will bear constant reiteration, that there is no national shortage of petroleum and the products derived from it. There are plenty of gasoline and fuel oil of all types. Proved reserves of crude oil still underground are ample. Production is sufficiently ahead of demand to insure against any shortage. The shortage, real or imaginary, is purely and simply one of transportation. Unfortunately, from the standpoint of distribution, the areas in which crude oil is produced are relatively remote from the large centers of consumption. And gasoline and fuel oil are bulky, unwieldy, liquid commodities, usually purchased by the consumer in relatively large quantities, that require special handling.

Getting the crude oil from the wells to the refineries, and the finished products to the dealer from whom the consumer purchases them is, then, the crux of the entire matter. And here, perhaps more than with any other commodity, old man economics plays the leading role. Because there are five major means of transporting the liquids under consideration over long distances, the situation becomes somewhat involved, leading to many of the misunderstandings that have been so prevalent in recent months. These five methods are by tank ship and tank barges (which are usually lumped together in any general consideration of the subject), pipe lines, railroad tank cars, and highway tank trucks, listed here in ascending order of relative transportation costs.

A small tanker such as used on rivers and canals; large ones carry up to 155,000 barrels

Strangely enough, when data were being collected for this article, exhaustive inquiries, directed to unbiased sources of information, failed to bring to light any quotable figures covering exact costs of transportation by all of these five methods. This was due largely to the complications that arise when seeking comparative costs in a field where there are a tremendous number of variables, any one of which can be applied to make the final figures prove just about anything desired by the one who juggles the figures. It was definitely determined, however, that the above listing represents the *relative* economics of oil and gasoline transportation, tankers being the lowest cost method and highway tank trucks the highest. The only definite figure that could be obtained, and upon which any reliance could be placed, other than one set mentioned later in this article, was that the relative cost of oil transportation between tanker, pipe line, and tank car is something on the order of one to three to six, when dealing with the run from Gulf ports to main points on the eastern seaboard centering around New York.

THUS it can be stated here that any cost figures advanced regarding any two or more of the methods of transportation, in an endeavor to prove a given statement, must be open to question unless they are based definitely on terminal points and existing transportation facilities between these points.

Before going into quantity figures regarding methods of getting oil from one point to another by means available and projected, let's step off to a distance and view this whole industry that revolves around the work of gleaning nature's crude product and getting the refined results into the gasoline tank of your automobile or the fuel-oil tank of your home-heating oil-burner.

Crude oil, as it emerges from the well, is piped into field storage tanks from which it flows into gathering lines, which, in turn,

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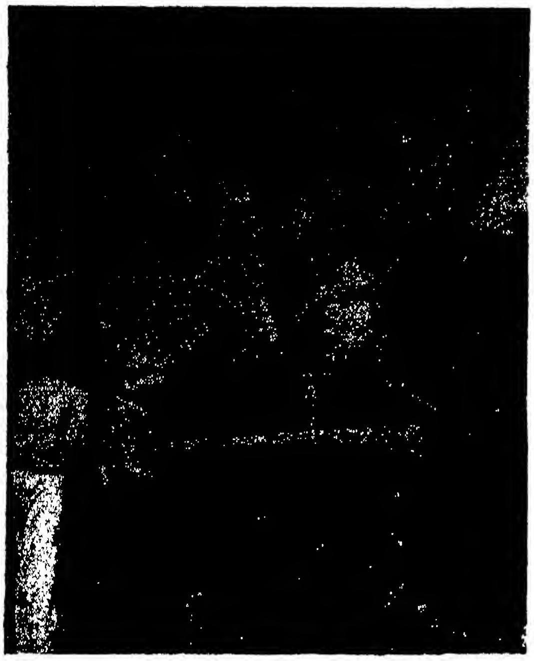
Bird's-Eye View of Petroleum Industry, 1940

Number of producing oil wells	390,000
Production of crude oil	1,350,000,000 barrels
Proved U. S. Reserves	19,024,515,000 barrels
Number of Refineries	557
Production of Motor Fuel	26,000,000,000 gallons
Transportation	
Mileage of Oil Pipe Lines	126,000 miles
Number of Tank Ships	467
Number of Tank Cars	148,000
Number of Tank Trucks	75,000



Laying a pipe line to insure a constant supply of petroleum products to consumers

feed into trunk-line pumping stations, to railroad loading racks, or to marine terminals. How it moves depends upon geography, economics, and other factors, but it will move certainly by the fastest, cheapest, and most convenient available route.

The oil which goes to the trunk-line pumping station thereafter will move through a trunk-line system of pipes ranging in size from eight inches to 16 inches in diameter. An eight-inch line normally can move 20,000 barrels (42 gallons to the barrel) about 120 miles a day. The speed of travel depends upon many conditions, including the nature of the terrain, the number of pumping stations, the pressure maintained, and the type of crude oil itself. A large number of pumping stations, a flat terrain, and a crude oil of average gravity mean faster travel; heavy oils must travel more slowly, and lifts over mountains contribute to delay, so that a day's journey may be only 50 to 60 miles.

Pushed on its way by powerful pumping stations, normally located some 40 miles apart in level country, and closer together where the line crosses mountainous regions, the oil next reaches semi-permanent storage in tank farms. These are merely collections of huge tanks holding from 55,000 to 100,000 barrels each, located at strategic points for the further distribution of the crude oil. Sometimes the tank farms are combined with marine and railroad terminals, and also with refineries.

Refineries may, as noted, receive their crude raw material direct from self-owned tank farms or again the oil may start on a journey, this time by one of several means. It may be withdrawn from storage and loaded into tank ships or tank cars or it may again enter a pipe line for further pumping to a distant point. In some cases, where only highway transportation is available, it may be shipped by tank truck. In any event, the oil next reaches refinery storage from which it is withdrawn as needed to feed the complex processing equipment from which it emerges in the form of gasoline, fuel oil, lubricating oil, and a host of other petroleum products.

But the end of the line has not yet been reached. These finished products must be transported from the refinery to distributing points and from these to local dealers from whom you purchase your gasoline and oil. Here, again, tankers, pipe lines, tank cars, and tank trucks take up the job and move the liquids on their way. Ordinarily the next stop, in the case of public consumption products, is the jobber's bulk plant, located in every large community, where local storage is provided and from which the materials may be distributed to local dealers, largely by tank truck. This transportation phase is best handled by tank truck because of the flexibility of the method and the fact that the product is now nearing its final destination and is being moved in relatively small quantities to a diversified group of outlets. Large industrial plants may receive their petroleum products either from the refinery direct or from bulk plants, depending on local conditions; bunkering stations, where ships are fueled, are supplied direct from refineries.

The variety of methods of distribution grows out of a variety of methods and volumes of consumption. In the case of gasoline, it is necessary for the petroleum industry to handle roughly 180,000,000 gallons every 24 hours—refining 60,000,000, moving 60,000,000 to bulk plants and retail stations, and pumping the third 60,000,000 into the fuel tanks of consumers. Since gasoline weighs about eight pounds to the gallon, this transportation job is equivalent to moving 720,000 tons of freight—all of it in liquid form.

From all that has been published on the subject of delivering gasoline and oil supplies to the ultimate consumer, the casual reader might not be blamed if he formed the opinion that a few miles of pipe lines and a handful of tankers, tank cars, and tank trucks were being used by the oil industry to transport these vitally necessary products to a point where he may purchase them. A few figures will quickly disabuse any such idea and will serve to indicate that the petroleum industry is making use of a vast and rapidly extending transportation system in an effort to avoid fuel shortages anywhere in the United States and to provide for the greatly increased demand for petroleum products in the name of national defense.

At the end of 1940 there were in use in this nation some 126,000 miles of pipe lines for the transportation of oil, 467 tankers (of which 50 have already gone to England under the Lend-Lease program), 148,000 tank cars, and 75,000 tank trucks. According to the American Petroleum Institute, there will be more than 10,000 miles of additional pipe lines built during 1941. Under construction and on order are 145 new tank ships, plus 11 which have already been completed during 1941.

During 1940, on the authority of the Bureau of Mines, the following quantities of crude oil were delivered to refineries in the United States by the methods noted: Pipe lines, 939,732,000 barrels (remember that there are 42 gallons to the barrel); boat, 277,589,000 barrels; and by tank car and truck, 38,990,000 barrels.

Largest of the new pipe lines, on which preliminary work has been started, will be one to transport oil from East Texas via Salem, Illinois, to Bayonne, New Jersey, and Philadelphia. Part of this 1500-mile line will be 24 inches in diameter, larger than any ever before constructed. Cost of this line will be some $75,000,000, but, according to Ralph K. Davies, Deputy Oil Co-Ordinator, such a pipe line could transport 200,000 barrels of oil daily to the New York terminal at a cost of $67,000 a day, com-

pared with a cost of $207,000 for the same amount of oil over the same distance by railroad tank cars. The capacity of this line, to compare it with another method of getting oil from here to there, would be sufficient to release from service on the same point-to-point run some 65 tank ships.

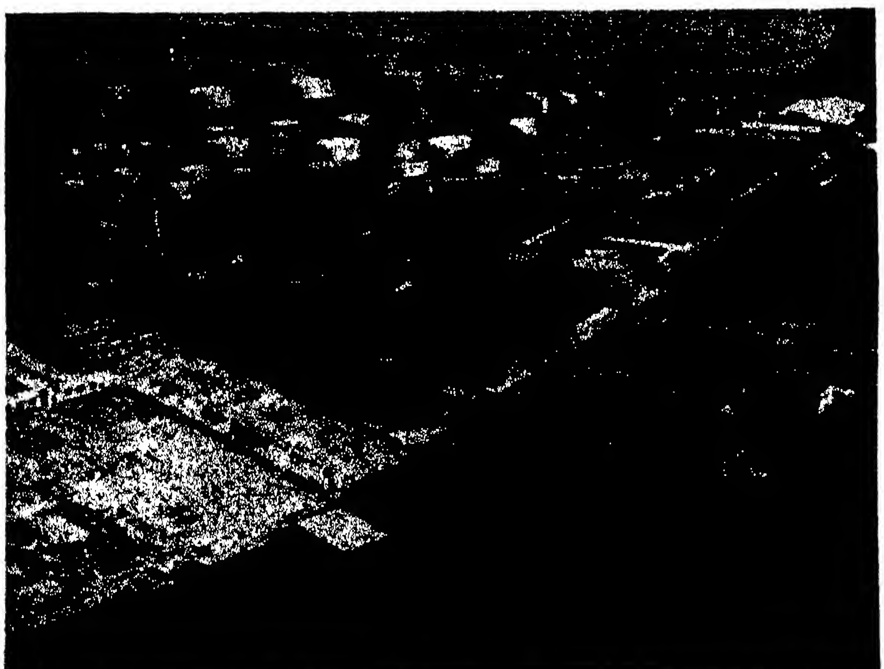
Other pipe lines that will help the general situation are the 1260-mile line from Louisiana to North Carolina and Virginia which should release 10 tankers; the 450-mile line from Florida to Tennessee which will not only relieve at least two tankers from this service but will also expedite deliveries along its route; and the international pipe line that stretches 236 miles from Portland, Maine, to Montreal, Quebec, which will eliminate a 10-day tanker trip and release four tankers for other routes.

Pipe lines, it must be remembered, constitute a 24-hour-a-day method of transportation, little affected by weather and other conditions that place limitations on mobile units on the rails, on the highways, and on the water. Maintenance is required, of course, but in general the service may be placed high in the reliability brackets. And pipe lines do make possible handling a huge quantity of oil during a given time, as has been shown. For purposes of comparison, however, the following figures are needed: Tankers can carry as high as 155,000 barrels (6,500,000 gallons) in one trip; tank cars hold from 8000 to 10,000 gallons; tank trucks have capacities up to 5000 gallons.

Oil companies own or lease 148,000 tank cars; capacity of each to 10,000 gallons

The pipe line is a little known method of transportation, but it has many economic superiorities. Out of sight and mind, largely buried in the ground, it is safe from sabotage and bombing. When it is not moving oil, it is storing oil, so that its cargo always can be unloaded merely by turning a valve. It never makes a return trip empty, but is working, either moving oil or storing it, 100 percent of the time. It is not affected by tides or temperature, it does not get into collisions or wrecks, and it ignores the weather. It is flexible in that it can be made to move its cargo either way, if necessity demands, and it can share its cargo at any waypoint.

It is often said that the materials necessary for the construction of pipe lines—from 400,000 to 750,000 tons of steel plate will be needed for the Texas-Bayonne line—may not be obtainable under national defense priorities, that these materials should be put to other purposes. Whatever may be the final outcome of this particular argument, sight must not be lost of the fact that oil is just as essential to national defense in all of its multitudinous aspects as are guns and ammunition, men and materiel. The oil has to be transported; whether steel goes into pipe lines or tankers is a question that can be settled only by a meeting of the minds of those who control the materials of construction and those who have the valuable background of experience in transportation of petroleum products.



All illustrations courtesy American Petroleum Institute

Combination tank farm and marine terminal for petroleum products

From the facts given it can be seen that the subject of whether or not John Q. Public, in any particular part of the nation, can buy gasoline at his favorite filling station in any quantity desired or can purchase sufficient fuel oil to heat his home during the coming winter, is not one to be settled merely by deciding on the relative merits or costs of one method of transportation over another. It is, rather, a case in which there must be a balancing of the economic features of all methods in an integrated whole that will insure adequate supplies of petroleum products to the entire country at reasonable costs to both producer and consumer.

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OIL

Coal Reserves Would Yield Oil for 3000 Years

Enough oil for 3000 years at the present rate of consumption could be made from the three trillion tons

of United States coal reserves, if it ever becomes necessary to make oil from coal, the Bureau of Mines reports. A hydrogenation process developed by the Bureau in one of its experimental laboratories has been tested on 13 different American coals, and has proved that crude oils, similar to crude petroleum and yielding large quantities of gasoline and other oil products, readily can be produced from all the coals tested. Tests are continuing on other important types of coal.

Total potential quantity of oil that could be produced from America's coal, based on the samples so far tested, amounts to about 3,800,000,000,000 barrels, the Bureau reports. Samples tested ranged from high-volatile bituminous coal down to the poorer quality lignites, with yields of crude oil from 168 to 78 gallons per ton of coal processed. Average yield from the total coal reserve, however, is estimated at about 50 gallons per ton, to include the quantities of coal which would have to be used for fuel and power in the processing plants.

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CLEAN-UP: Special vacuum hose is used in one of the largest airplane company's plants to suck up and carry away any loose bolts, nuts, or shavings that may be in the hulls of bombers after their completion.

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The government experts did not estimate costs of production, but these are known to be considerably greater than the present cost of producing crude petroleum from oil fields. Hence this process, and alternative possibilities of producing crude oil from oil shales, probably would not be introduced commercially until the unknown future day when America's liquid oil reserves are in serious danger of depletion. Several European countries, notably Germany, have been using hydrogenation and other processes commercially for a number of years under government subsidy, and are producing large quantities of oil products from coal.

Necessity for the introduction of coal hydrogenation or other processes in this country probably lies in the remote future, according to petroleum geologists. At a recent meeting they reported little evidence that America is anywhere near finding its last oil field. They charted huge areas in the United States, Alaska, and Canada as possible locations of undiscovered petroleum reserves.

FREEZE-RESISTANT

Synthetic Rubber Resists Low Temperatures

One of the drawbacks of synthetic rubbers in many automobile and aircraft applications has been a tendency to become hard and brittle when exposed to sub-zero temperatures. A new type of neoprene, recently announced by Du Pont, is claimed to be as freeze-resistant as natural rubber and still to retain the oil-resistant qualities which make neoprene so valuable in many cases.

GENERATORS

Portable Engine-Driven Units, Water or Air-Cooled

When electric power lines fail, due to uncontrollable conditions, manufacturing plants of all kinds must stop operations unless they are provided with stand-by generating units. In hospitals, theaters, and public buildings, power failures may result in loss of life or serious injury.

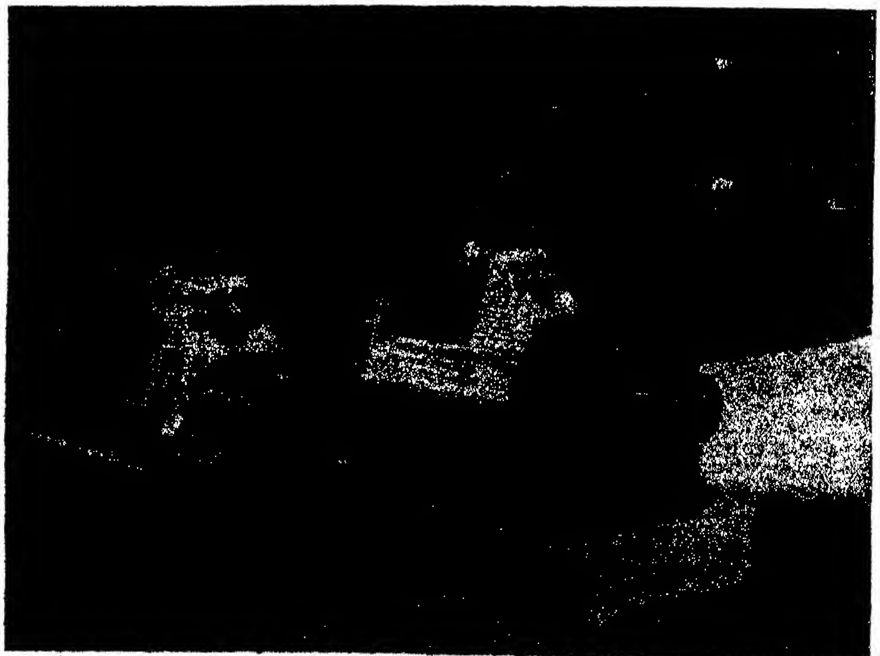
A new series of stand-by generating plants designed to protect against the loss and hazards of power failure has recently been announced by Bardco Manufacturing and Sales Company. One of our illustrations show two of these stand-by plants in the film laboratory of Warner Brothers in Burbank, California. Claims made for these generating plants, which are available in a range of capacities from one kilowatt to 200 kilowatts, alternating current, and from one kilowatt to 100 kilowatts, direct current, are that they start and stop automatically, have automatic voltage regulation and safety controls, and can be run in parallel with accurate synchronization. It is claimed that the units can take over operation within three seconds after a power-line failure. They are supplied to operate on Diesel oil, gasoline, gas, and butane. Both water-cooled and air-cooled motors are available in a wide range of powers.

SELF-CLEANING

Industrial Equipment Protected by "Graphoid" Surface

A simple method of obtaining a combination of dry lubrication, rust-prevention, and a "self-cleaning" action, worked out in connection with equipment for the manufacture of corrugated fiber-board, appears to have some interesting possibilities in connection with the protection in operation of other types of industrial equipment.

The development originated in an attempt to eliminate the sticking of sodium silicate to the hot platens of corrugated fiber-board



Provide quick take-over for power emergencies

making machinery. It was discovered that when the platens were provided with a "graphoid" surface, they then became virtually self-cleaning, in addition to being rust-proofed. Furthermore, the lubrication provided by the graphoid surface minimized wear on corrugating rolls.

At first it was thought that the use of graphite would tend to discolor the work passing through the machinery. It was found, however, that when "dag" type of colloidal graphite, produced by Acheson Colloids Corp., was used that the extremely fine particles adhered closely to the platens. After the excess graphite had been wiped off in the first few feet of travel of the material over the rolls, after each application, no noticeable transfer of graphite to the work occurs.

The colloidal graphite was applied to the hot platens in an aqueous suspension. Under the elevated temperatures, the water readily evaporates, leaving a film of graphite particles on the surface. Under heat and pressure these particles form a graphoid surface on the platen.

ACCIDENTS

Often Due to Attitudes of the Victims

THE "jinx" that causes some workmen to have repeated accidents at their jobs has been identified as the attitude of the accident victim himself by Dr. Alexandra Adler, of Boston Hospital and the Harvard Medical School, reports *Science Service*.

The accident-producing attitude is different in different workers and in different nationalities, it was revealed by study of 100 industrial workers in Europe and 100 applicants for workmen's compensation in Massachusetts.

In America, over one-fourth of the accident-prone workmen were over-fearful. That fear of accidents can produce them was demonstrated by a test on soldiers, quoted by Dr. Adler in her report to the *American Journal of Psychiatry*. Half the soldiers on a cross-country ride were told that a ditch lay ahead of them. The other half were not informed. Three-fourths of those who fell into the ditch were from among those who had been warned.

More than 23 percent of the American accident-prone workers had a fatalistic attitude that they were sure to be unlucky. Nearly 20 percent had a longing to be pampered and were happy while being nursed after an accident. Over 13 percent had a revengeful attitude toward parents or educators. In these, Dr. Adler considers that the repeated accidents are a sort of substitute for suicide.

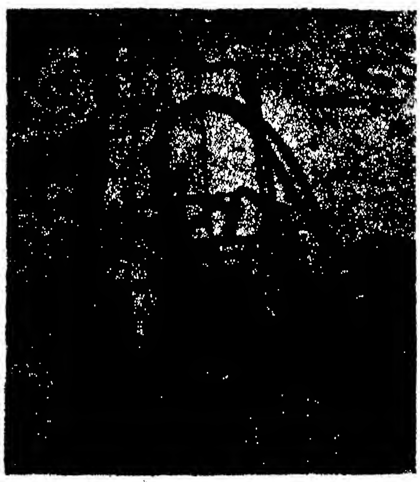
These were the attitudes most frequently to blame for accident repetitions among American workers. Among the European workmen, a revengeful attitude was responsible in 56 percent of the individuals. Alcoholism accounted for 12 percent (as compared with only 3.3 percent among Americans), the "unlucky" attitude for 10 percent, and the longing to be pampered for 6 percent.

Aside from the alcoholics, only eleven individuals could blame disease or mental deficiency for their repeated mishaps.

SCRAP SALVAGE

Street-Car Tracks are Important Source

TIGHTNESS in available scrap, especially of the proper grade, is becoming a threat. Steel mills cannot produce full-capacity tonnage because they must use low-grade melting steel; and they are being forced to dip deeply into their inventories of scrap, reducing them to an abnormally low point, at a time when they would normally be building up their stocks for the winter months.



Slices imbedded rails . .

In the light of this condition, steel mills, municipalities, and various types of traction companies should investigate the fact that thousands of tons of scrap rail can be obtained by the removal of abandoned streetcar tracks which are now embedded, unused, in the streets of hundreds of cities throughout the country. Furthermore, the removal of these rails can be economical and efficient through a method, recently developed, in which a portable, oxy-acetylene cutting machine is used.

Aside from the simplicity and high speed of cutting, which make this method so efficient, there also are economies which can be realized. The method permits removal of the rail without breaking adjacent pavement, even when asphalt, macadam, stone blocks, or brick have been laid flush with the top of the rail. Thus repaving costs are kept at a minimum, and cost of removal is more than covered by the sale of the scrap rails.

. . which can be pried loose

In this method, the cutting machine is positioned on a special track; two or more sections of such a track can be used so that the cutting operation can be carried on continuously. The cutting blowpipe of the machine is equipped with a bevel-cutting nozzle, and a single cut is made at an angle along the groove of the rail so that the top of the rail is severed from the web in two longitudinal sections. The cut rail can then be easily removed with a pinch bar.

SHAFT HARDENING

Inductive Process Reduces Rejects

HEATING time for hardening crankshafts has been cut from 12 hours to less than five minutes by 2000-cycle inductive heating at the Chicago tractor plant of the International Harvester Company. Involving five different sizes and types of shafts for Diesel and gasoline engines, the method has simplified balancing, obviated the normal pickling processes, and increased core toughness. With this installation, which was the first

licensed by the Ohio Crankshaft Company, more than two million shafts have been so produced without a rejection for incorrect hardness.

Formerly the drop-forged shafts were normalized, hardened and drawn, pickled or shot-blasted to remove scale, then machined and ground. Though durability of main bearings and connecting-rod bearings is almost directly dependent upon their hardness, this physical property was limited by machining operations after hardening. Carburizing these particular shafts was not a practical means of increasing hardness, because distorted shafts could not be satisfactorily straightened afterward. Final hardness was between 25 and 30 Rockwell C. Shafts are now normalized, completely machined except for final finish, then heat-treated on the wearing surfaces only to a hardness of from 55 to 62 Rockwell C, drawn at 350 degrees Fahrenheit, and ground. Pickling is no longer necessary, since inductive heating introduces no scale. Using conventional hardening methods, shafts previously were made of a nickel-alloy steel, which has been made currently almost unavailable by defense restrictions. With inductive heating, the more costly nickel steel has been replaced by a readily available carbon-chrome steel. Total rejections for metallurgical defects have been cut from the previous 5 percent to an average of less than one percent.

Inductively hardened shafts take a better final finish than those produced by the old method, because of their increased hardness; and breakage of shafts in service has been reduced materially by the greater toughness of the shaft core.

NO CORONA

Effect Eliminated by Semi-Conducting Paint

Elimination of corona in the air spaces between coils of the end windings of rotary machines has been accomplished by treating the end-turn insulation with Coronox, a new semi-conducting paint. Since machines of above 10,000 volts came into use, corona has been a troublesome element in high-voltage generating equipment. Resulting from ionization of electrically overstressed gases, corona may appear in any of three locations: in the slots, around coils immediately beyond the ends of the slots, and in the air spaces between various coils of the end winding.

A single proper resistance value, such as the 10 megohms per square inch resistivity of Coronox, can reduce the voltage stress across the end turn insulation sufficiently to eliminate corona. In treating the stator coils, glass binder tape is completely filled with Coronox which results in a thick, firmly anchored, semi-conducting layer on the surface of the coil. The parallel connecting rings and support rings are treated in a similar manner. Finally, a long life insulating varnish is sprayed over the whole end winding to protect the Coronox and increase its stability.

Two often measured properties of electrical insulation are the flashover voltage and the breakdown voltage. The flashover voltage of Coronox-covered surfaces is actually greater than that of highly insulating surfaces. The breakdown voltages for treated coils should be higher than for untreated coils because the Coronox treatment eliminates concentrated voltage stresses at the edge of the slot.

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EXPLOSIVES—During actual transportation by rail of explosives of all kinds in Canada and United States in 1940 there was not a single fatal accident and only one person was injured.

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STRIP MILL

Fastest, Highest, Now in Operation

A new 5-stand cold strip mill incorporating a number of "firsts" in electric drive and control for steel mills has recently been put into operation at the Irvin Works of the Carnegie-Illinois Steel Corporation, at Pittsburgh, Pennsylvania. The highest-powered cold-rolling mill for tin mill products in the world, it has been operated at a delivery speed as high as 3750 feet per minute and is capable of 3850 feet per minute without exceeding the specific ratings of the mill driving motors.

A total of 11,400 horsepower is employed to drive the mill. Stands 1, 2, and 3 are driven by direct-current motors rated 800-, 2000-, and 2500-horsepower respectively. Stands 4 and 5 are driven by double-armature D.C. motors of 2500- and 3000-horsepower respectively. For driving the tension reel, a 600-horsepower double-armature motor is employed. All of these motors are of the special mill type, designed by the General Electric Company.

Even more spectacular as to size are the two 4000-kilowatt generators—largest D.C. generators ever built—which supply power to the main mill motors and tension reel at 750 volts direct current. The driving motor of the motor-generator set is an 11,300-horsepower synchronous motor operated at 6600 volts.

Installed between the five stands are four indicating tensiometers which enable operators to read the actual pounds of strip tension as the strip proceeds through the mill. Tapered tension control of tension between stands provides for a more uniform finishing gage at lower strip speeds. Automatically, at low strip speeds, this control system permits the tension to be increased so that the finished strip may be "on gage."

CASEIN

Prices Rise in Step with Steel Demand

Casein prices offer an example of the complications sometimes traceable in trade and industry, according to a report on the dairy situation, issued by the United States Department of Agriculture. The increase in casein prices in recent months, says the Bureau of Agricultural Economics, shows how a change in demand for one product may affect a change in the demand for another seemingly unrelated commodity.

In order to increase steel production, more coke was needed. To produce more coke, the coke ovens had to be operated at higher temperatures. This resulted in the production of less phenol. Phenol is used in glues which compete with casein glue. The restricted production of phenol glue caused prices of both phenol and casein glues to rise. As a result casein prices increased. It has been difficult to increase the production of casein because of the demand for dried skim milk and cheese which exists under the food-for-defense program.

NEW PRODUCTS, NEW MARKETS

If ever the trend in any industry pointed toward a favorable future, come what may in a troubled world, that of the chemical industry seems, from this observation post, to be the most promising. Although the industry as a whole boasts of an ancient lineage, going back many centuries, there is a peculiar quality of ever-newness that sets chemical manufacture and research apart from other types of endeavor. In fact, it might be said that the chemical industry is reborn about every decade, bringing into extensive use new products hitherto unknown and opening new markets that, strangely enough, appear to profit without making corresponding drains on other industries. Thus, while past performances may serve to indicate general trends for the future, they cannot always be used as signposts pointing toward specific developments of importance to the world at large.

In the calm, halcyon days before World War I, for example, there was little thought that someday the chemical industry of the United States would figure largely in the production of explosives and dyestuffs; German monopolies calmly batted down any ambitious endeavors that attempted to invade their preempted ground. Then came the War. Virtually overnight there was developed in this nation an industry that asked no favor of anyone, that produced needed materials in any quantity and of a quality that bespoke Yankee ingenuity intelligently applied in a vital line of endeavor.

Next came the shining example of lacquers, synthetically produced to give surface coatings with outstanding qualities of durability, beauty, and ease of application. Then an upsurge in the production of rayon, already many years old but awaiting the Midas touch of research and mass production. Cellophane, plastics, new metallic alloys, new dyes, hitherto unheard-of drugs, nylon, synthetic rubbers, anti-knock gasolines, cheaper manganese, and a long list of other products brings the subject of chemistry's contributions to living about up-to-date and serves sufficiently to prove the point regarding ever-newness.

Critical study of advances in the chemical industry brings to light one important factor that, more than any other, will govern the future. Until just recently the industry was busy producing materials with which better work could be done on other materials. Dyes, for example, that would give better and more durable colors to existing fabrics; additives to increase the life and wearing qualities of rubber; ways and means of improving the thousand and one products of industry that were already in use. Tools, if you will, tools with which to extend the usefulness of materials that, of themselves, are usually considered to be far apart from routine operations of the chemical industry.

But now the picture changes, has been changing, in fact, for some time past. Tools of industry become incidental to chemistry; raw materials is the new field of endeavor, and a field that performance has already proved. Not only is the industry producing dyes for fabrics, but it is also producing the very fabrics themselves, and producing them from common, inexpensive materials. No longer is the only rubber aim of chemistry to improve the natural product; synthetic rubber claims a large share of attention. Are there moldable products that need durable colors? Build the color right into them and produce new materials that have characteristics not available in any product of nature—plastics.

Thus the chemical industry as a whole is possessed of a two-tined weapon with which to make its way in the world. It can make the tools of industry, and can produce the raw materials with which industry has to work. And never let it be said that here is an *ersatz* business, built on the need for substitutes. The plastics industry alone is sufficient to give the lie to any such thought. Here has been produced a whole group of new materials that, in a multitude of cases, do a better job than was done by predecessors. Here are materials that can be used where no other products give comparable results. Here, in a word, is a source of raw materials, made available by the chemical industry, that out-rivals anything that nature has ever produced.

With such a background of accomplishment, and with almost daily announcement of new developments from the chemical laboratories of the nation, it is apparent that the chemical industry of the future bids fair to surpass even itself in worth-while accomplishment.

TOWARD BETTER HOUSES

It is now becoming more and more apparent that the trend toward complete prefabrication of houses is a limited one, confined largely to the low-cost housing field, but the prefabrication idea is being applied in so many other ways in the building-supply industry that it is assuming a place of no small prominence. This trend is exemplified by increasing use, in new housing construction and in renovation of existing buildings, of factory-fabricated window units, kitchen cabinets, china closets, wall units of plywood and other materials, and so on. Just how far this particular phase of prefabrication will go will depend largely on the ingenuity of manufacturers in supplying units that can be built by mass-production methods, yet will retain sufficient individuality to suit varying consumer tastes.

ALL SILK IS NOT IN STOCKINGS

While the ladies are carefully guarding dwindling supplies of silk hose and keeping a critical eye on the stocking industry's efforts to produce satisfactory limb coverings from high-count cotton, the electric wire and instrument manufacturers are preparing to get along without the silk that they formerly used to the extent of thousands of pounds annually. General Electric, for example, will use rayon and nylon as a substitute for silk insulation on wire when present silk supplies are exhausted. Silk tape, used in some phases of their work, will be replaced by cotton or rayon. And so it appears that a year or so hence many of us may wonder why we ever worried at all about shortage of silk!

18990 —*The Editors*

Escape From Surgery

New Telescopic Technique of Internal Examination is Saving Many from Operations

ANDREW R. BOONE

WITHIN recent months several hundred persons who suffered from ailments of vital organs, which defied diagnosis by X-ray or other standard methods of examination, have escaped major surgery.

An ingenious instrument combining tubes, mirrors, telescope, brilliant light, tiny scissors, and means for inflating the abdomen, enables surgeons to study the organs within the abdominal cavity. In 20 minutes, a doctor, trained to recognize what he sees through the 'scope, can catch close-up glimpses of the tissues, describe their conditions to other consultants, and send the patient back to his room.

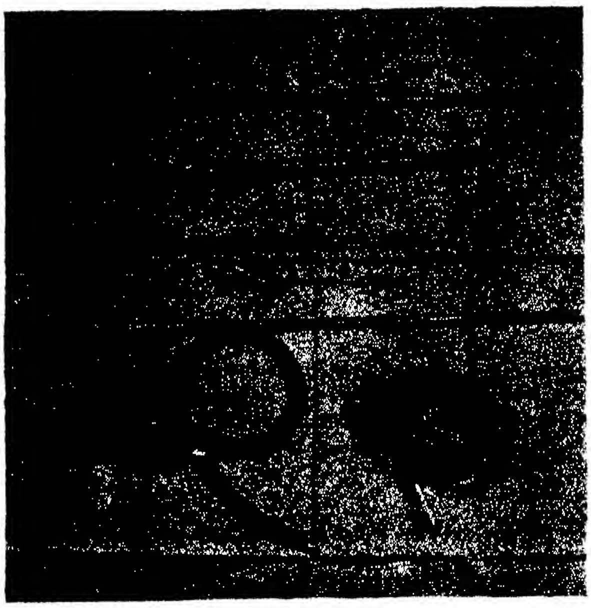
It was Dr. John G. Ruddock, Los Angeles surgeon, who perfected the device, known as the Ruddock Peritoneoscope.

For two decades, physicians and surgeons have sought an efficient means for looking inside the body without resorting to surgery. To insert the peritoneoscope, an incision only one half inch long is required. A single stitch closes the wound. Patients undergo the examination in comfort, a local anesthetic preventing pain, and, because the nervous system suffers little or no shock, they seldom miss a meal when undergoing the novel experience of revealing their inner workings to their doctors.

Dr. Ruddock collaborated with technicians of the American Cystoscope Makers, Inc., in evolving the 'scope. In addition to making it possible to view the organs, the device enables surgeons to take specimens of tissues suspected of being diseased for laboratory analysis; also to make such minor repairs as clipping adhesions.

The 'scope has five essential parts. First, a dull-pointed needle five inches long enables the surgeon to penetrate the abdomen and distend it with air. After withdrawal of the needle, a metal sheath containing a removable tip is inserted. If fluid is present, a suction tip replaces the solid tip.

Next, for making an examination, the telescope is slid into the sheath. The surgeon then simply looks into the eyepiece, and scans his field through the tube and mirrors. A tiny light is placed near the tip, ahead of the optical system.



Instruments used in the examination (see text)

By rotating the 'scope, the surgeon sees in a few seconds a field two inches deep, around a complete circle.

Should tissues suspected of being diseased be encountered, he sends down a pair of tiny forceps. Guiding them carefully under the brilliant light, the surgeon eases the open forceps into the tissue, closes them with thumb scissors, and removes the specimen. When closed, the tip forms a cup to hold the material.

He next observes the sampled area intently, and if bleeding takes place, he touches a switch, sending high-frequency electricity down through the lower end of the forceps to coagulate the blood.

Dramatic medical history is already being written in hospitals all over the nation because Ruddock's genius brought the 'scope into existence. In a western surgery, several physicians met recently to study the case of a girl whose illness doctors had tried in vain for three years to diagnose. Now she lay on the table, discouraged, critically ill, too weak to withstand exploratory surgery.

One of them experienced in use of the peritoneoscope, bent over the patient. He marked a site just below the umbilicus, and carefully measured the point for a short incision. After encircling the site with novocaine, he made the opening, inflated the abdomen with air forced down with a hand syringe, and inserted the 'scope. Through the tube he first examined the liver. Swinging slowly around in a clockwise circle, he viewed the spleen, the parietal wall, the intestines, and finally the appendix. Then he returned to the liver, and studied this organ intently.

THE clock had measured off 19 minutes when he closed the incision. For a half hour he discussed his observations with his colleagues. The girl's affliction, they decided, was actinomycosis, a rare infectious disease involving enlargement of the liver, due to ray-fungus. Medication, not surgery, was indicated; and her physician proceeded with a correct course of treatment.

An early user of the peritoneoscope was Dr. R. Nichol Smith, another Los Angeles surgeon and a friend of Dr. Ruddock. Dr. Smith began using the equipment to examine patients whose troubles had eluded diagnosis. One night his daughter complained of a pain in the right side. The symptoms indicated an inflamed appendix. If it were really the appendix, surgery could not wait.

Next morning, shortly after breakfast, Dr. Smith transported the girl to a hospital. At 11, he conducted a peritoneoscopic examination, but through the lens her appendix appeared to be quite normal and healthy. He found the trouble elsewhere, and a few minutes later the young lady was enjoying the comforts of a bed. At one o'clock she ate a light lunch;

at six, a four-course dinner. Twenty-four hours after entering the hospital, she went home, having suffered none of the discomforts of surgery. Medical treatment corrected the condition in a few days.

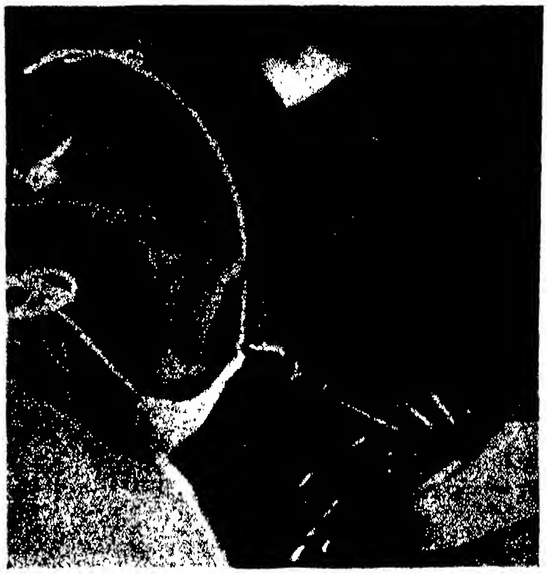
Marveling at the ease with which he found a cure for a member of his own family without resorting to surgery, which usually involves a two-week stay in the hospital, considerable expense, and perhaps several months to regain lost strength, Dr. Smith resolved to find some way of teaching other surgeons how to use the peritoneoscope and to interpret their observations.

After consulting Dr. Ruddock, he sought out Billy Burke, a Hollywood cinematographer who specializes in making surgical pictures. The Winship Foundation supplied funds. Then doctor and photographer went to work.

Recently, the two men completed the picture. It is an amazing film document which portrays in color the technique from beginning to end. Thirty-seven scenes, moving back and forth between exterior and interior views, reveal alternately the doctor operating the 'scope and close-ups of diseased organs. An enlarged spleen, partial obstruction of the intestines, an inflamed appendix, a hobnail liver, from different patients, parade across the screen. Each appears as a circular image, exactly as a surgeon sees it when looking through the 'scope.

On the title appears these words: "A photographic reproduction of views as seen through the peritoneoscope." So real is the illusion that one gets the feeling he is actually peering down into a living patient. This is precisely the effect Dr. Smith sought.

To get the unusual shots, the surgical photographer attached an 11-inch tube to the lens of his camera, and fitted an iris stop in the lower end of the tube. By stopping down, he obtained a circular field, thus avoiding the stagey effect of filling the screen with these shots. Cadavers in a nearby hospital were the subjects.



Dr. Smith views gall bladder and liver

How a specimen of tissue is taken

The search for an efficient means of looking into the abdominal cavity dates back to 1901, when Dr. G. Kelling, a German researcher, reported partial success. Dr. Kelling inflated the cavity of a dog, and examined the organs through a cystoscope. Nine years later Dr. H. G. Jacobaeus developed a similar procedure in Stockholm, Sweden. Other scientists in Denmark, Austria, Russia, South America, France, Italy, and the United States worked on the problem. Several of them patented devices for using lights both inside and outside the body to illuminate their field.

Now, through the peritoneoscope, doctors visualize pathologies never before visible. While they cannot visualize all pathologies within the abdomen, frequently they can trace the sources of tumors, determine whether to operate for removal of cancers, and study pelvic organs in their natural colors. Little more than a month is required for a surgeon to learn its use. Dr. Ruddock has reported diagnoses of 44 diseases in 900 patients as he looked through the instrument. It is thought that the peritoneoscope also may permit certain surgical operations without opening the abdomen by making it possible to pass especially designed instruments down through the tube and to guide their work by

Making a motion picture, to help in teaching other surgeons the technique

Viewing wall of peritoneum

means of its tiny mirrors and light. Surgical operations often are performed by means of a remarkable variety of tiny but ingenious instruments inserted through the similar sheath of the cystoscope, though that instrument is used primarily for the examination of the interior of the bladder and for testing the kidneys—and now the same principle may be applied to the peritoneoscope.

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MASTER DIET

How to Attain an Adequate Diet

HOME economists of the United States Department of Agriculture have translated the recently established "yardstick of good nutrition" for the United States into a master diet plan.

The "yardstick" set up by a committee of eminent nutritionists defines an adequate diet in scientific terms—of recommended daily allowances for different elements that human beings need. The master diet plan translation gives the same information in terms of different groups of food that need to be represented in the diet every day.

Follow this diet plan, say the nutritionists, and the vitamins, minerals, and other food essentials listed in the yardstick will take care of themselves.

Milk—three-quarters to one quart every day for a growing child; one quart for an expectant or nursing mother; one pint for everyone else. Tomatoes, oranges, grapefruit, green cabbage, raw salad greens—one or more servings for everyone. Leafy, green, or yellow vegetables—one or more servings. Potatoes, other vegetables, and fruits—two servings or more a day. Eggs—one a day (or at least three or four a week). Lean meat, poultry, fish—one or more servings a day. Cereals—at least two servings of whole-grain products or "enriched" bread. Fats and sweets—some butter or fat rich in vitamin A every day, and enough more fats and sweets to satisfy the appetite.

THIAMIN

A B-Vitamin Deficiency Accounts for Many Ills

SHORT TEMPERS, inefficiency, headaches, backaches, and stomach distress after meals are what come from eating regularly over a long period a diet that is just a little short in the morale vitamin, B_1, diet studies at the Mayo Clinic show, according to *Science Service*. Eleven women, chosen for their previous record of good health, lack of "nerves," willingness and ability to co-operate, were the human guinea pigs for this study just reported by Drs. Ray D. Williams and H. L. Mason.

In contrast to previous studies in which human subjects developed typical neurasthenia on diets with a very low vitamin B_1 (thiamin) ration, these women were given the sort of diet thousands of American families regularly eat. It consisted of white bread, corn flakes, polished rice, sugar, skimmed milk, beef, cheese, egg white, butter, vegetable fat, cocoa, gelatine, canned fruits, canned vegetables, and coffee. It was a little but not markedly low in its content of vitamin B_1.

After three months, one of the women developed such disturbing symptoms that she had to be taken off the diet and given doses of the vitamin. The others continued with the diet for from about four to six and one-half months. Besides low blood pressure, capricious appetites, anemia, and signs of disturbed heart action, these women, after several weeks on the diet, showed the following changes in their normal behavior:

The subjects became depressed, irritable, quarrelsome, and fearful. They became inefficient in their work because of generalized weakness, were inattentive to details of their tasks, were confused in thought, uncertain of memory, and lacked manual dexterity. These abnormalities progressed to a degree which disabled six subjects in the performance of work to which they had been accustomed for a long time.

Headache, backache, dysmenorrhea, soreness of muscles, gastric distress after meals, sleeplessness, tenseness, paresthesia (burning or prickling feelings), intolerance to noise, and increased sensitivity to painful stimuli were frequent complaints, although these signs and symptoms were entirely of a subjective nature. The significance of these evidences of abnormalities was increased, however, because of the careful selection of subjects, their continuous co-operation and ability to work before the period of restriction of thiamin (vitamin B_1), and their subsequent normal behavior when, without other change in environment or diet, the allowance of thiamin in the diet was increased.

LAME WING

Arm Ailment Frequently Due to Bearing Deposit

WHEN a veteran baseball pitcher (occasionally a youngster, too) suddenly develops a severe lameness in his "money arm" and is no longer able to throw his "fast one" because of the severe jab of pain he gets in his back shoulder muscles, he is likely to be suffering from the formation of a bony deposit on the bearing surface of his shoulder-joint very much like that which gives older persons arthritis, states Dr. George E. Bennett, member of the Johns Hopkins medical faculty, in the *Journal of the American Medical Association*, reports *Science Service*.

Part of the pain is felt in the shoulder itself, and part is "referred" to the deltoid muscle, which is the broad, triangular muscle spreading out from the shoulder across the upper part of the back. This referred pain is due to the pressure of the bone accretion on a nerve, Dr. Bennett explains. It is possible to remove this bony growth by surgical operation, but this involves cutting loose part of the deltoid muscle, and is at best a risky procedure.

"My experience," Dr. Bennett states, "is not sufficient to advocate this operative procedure with the assurance that a baseball pitcher will be able to resume his profession."

Gold From the Grave

Central American Indian Cemeteries Yield Exquisite Ornaments of Almost Pure Metal

J. ALDEN MASON

Curator, American Section, The University Museum of the University of Pennsylvania

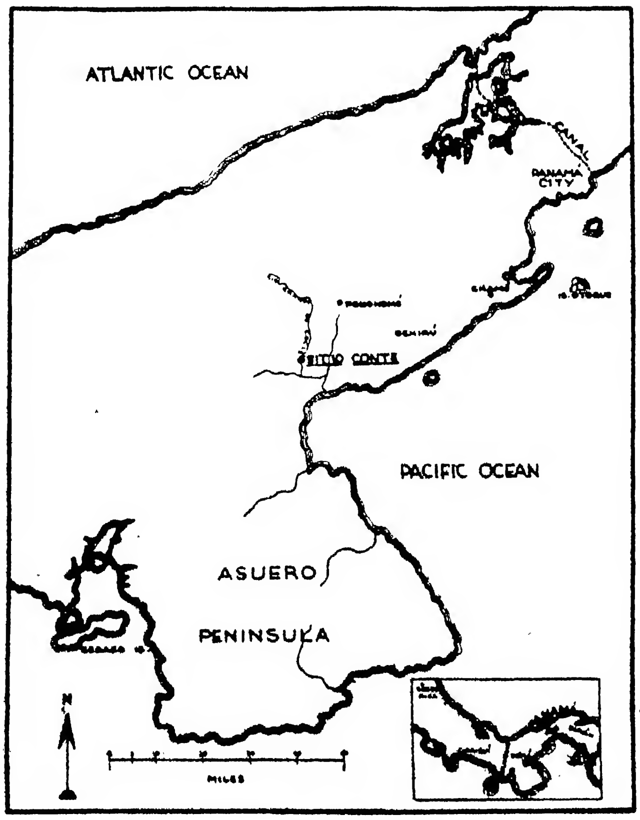
WHEN the first Spanish conquerors came to Panama early in the 16th Century, they found no buildings of masonry such as they were later to encounter in Mexico and Peru; naturally, they did not expect any. They found what they expected, from their experience in the West Indies—Indians living in houses of wood with thatched roofs. They did find, however, what was to them much more important than masonry temples and palaces—a people with a wealth of ornaments of gold, a metal that had been very scarce in the Antilles. As everywhere, they warred upon the natives, captured the chiefs, and demanded enormous sums of gold as ransom. The first expedition to the region of Coclé, that of Gonzalo de Badajoz in 1515, in two months secured gold ornaments to an apparent present gold value of $90,000 to $150,000, and Chief Parita tried to buy them off with baskets of gold objects worth some $250,000 to $300,000.

Also, they dug up the Indian cemeteries for the gold ornaments that were interred with the chiefs. Most of these exquisite examples of the goldsmith's technique were melted down and sent to Spain; only a very few examples that were sent abroad intact have survived to the present day.

For over four centuries the digging of Indian graves for their gold content has been a recognized industry in the Isthmian area. In some regions, such as the Chiriqui district in western Panama, the slab-covered graves are discovered by sounding with a metal rod; in others there are no surface indications.

Naturally, very few large cemeteries escaped the careful search of the Spaniards and their native successors. One that did was discovered quite by accident about the beginning of the present century in the province of Coclé, on the Pacific slope about 70 miles west of the Canal Zone. In the flat terrain the rivers frequently change their courses during the high floods of the rainy season, and

Above is the pit during excavation, showing several graves, excavators, and staff members; also, a small, square grid for plotting and photographic recording by coordinates, such as archeologists employ for permanent record. Below is a map of the region, with a small insert showing its relation to the Canal Zone



the Rio Grande de Coclé, in making a new bed, cut through a large pre-Columbian cemetery. Pottery vessels, gold ornaments, human bones, and other buried objects began to wash out of the bank. The owners discouraged private digging and did little themselves. Such discoveries generally take a long time to reach scientific ears, and it was not until 1930 that careful excavations were begun there by the Peabody Museum of Harvard University, which continued work in 1931 and 1933. Seven years later, in 1940, the University Museum of the University of Pennsylvania sent an expedition to the same site; I had the good fortune to be in charge.

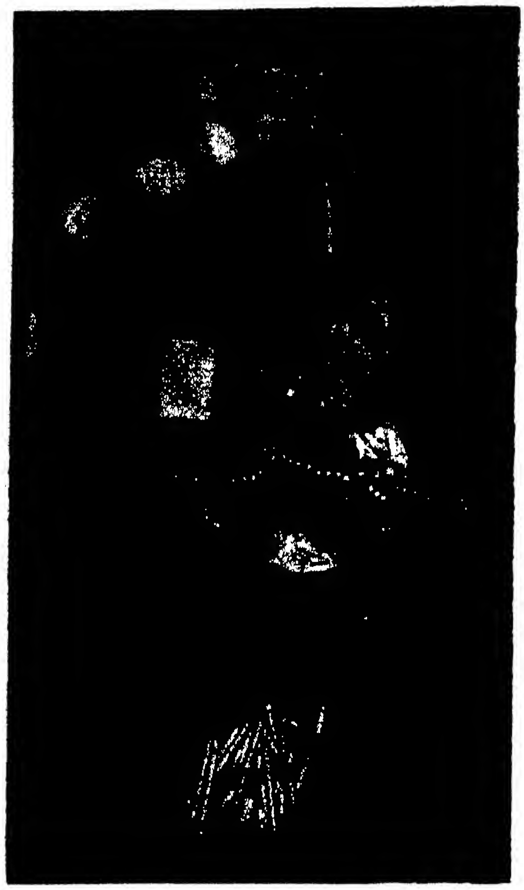
The cemetery is known as the Sitio Conte, or "Conte Site," from the name of the owners. In high floods the field is completely covered with water and the deepest graves probably are below water level during the greater part of the

year. Only in the dry season, from January to April, is it possible to dig. Unlike the Atlantic slope, the region is open and grassy, cattle-raising being the principal industry. The constant trade winds make the high temperatures endurable, and in the dry season there are no mosquitoes and consequently there is no malaria. Though venomous snakes are found, their proportion among the total serpent population is not large.

A PIT some 55 feet in maximum length by half that in width was dug, in many places down to the water table at about 13 feet from the surface. Little was found in the upper five feet, and probably part of this was accumulation of the last four centuries. In the space excavated, some 30 graves and caches were encountered, ranging from caches of a few buried pottery vessels or stone objects to graves ten feet in diameter and containing hundreds of vessels and over 20 interments. Nine of the graves might be considered as large.

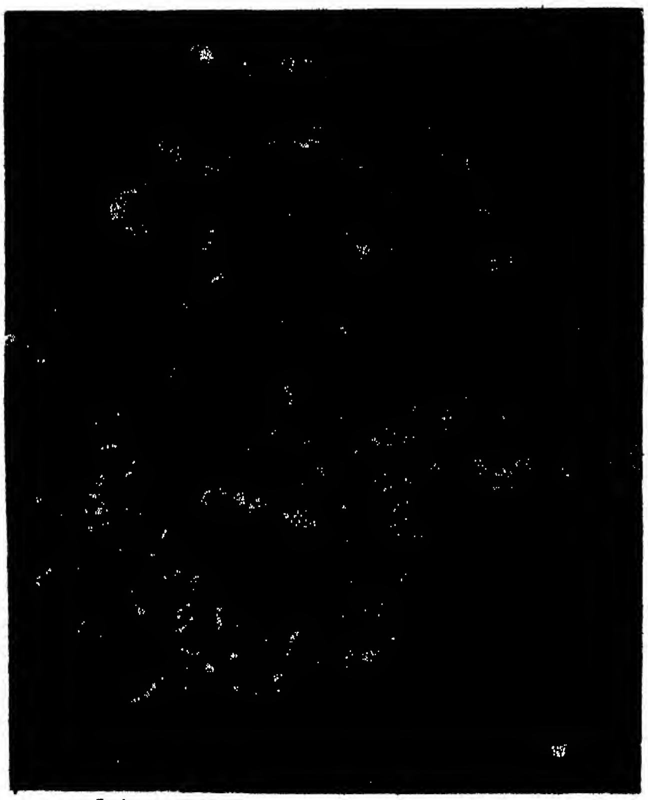
The task of determining the characteristic types of pottery and other objects of the different periods, one of the major functions of archeological research, could not be done by the usual stratigraphical methods. In a site where soil and debris have collected by gradual accumulation, the older objects are at the bottom, the recent ones on top, but at the Sitio Conte the latest graves are often the lowest, and the temporal relations have to be determined by noting when a later grave has cut through an earlier one. The criteria are often confused, since sometimes in making a later grave, the earlier ones cut through were robbed of their best objects which were then interred in the new grave.

The task of the natives in digging graves ten feet square to a depth of eight feet without the use of metal implements must have been a stupendous one. Since the big, very deep graves could have been made only at the height of the dry season, it is obvious that the bodies of the chiefs must have often been kept for many months, and during this time probably quantities of pottery vessels were made especially for grave furniture.



Gold ornaments in the richest grave

The accounts of the earliest Spanish chroniclers agree so well with the nature and contents of the graves that it is likely that the cemetery was used until approximately the time of the Spanish Conquest, and the earliest graves are probably not older than two centuries before this, about 1300



Left: A two-grave area showing shattered pottery, skeletons. *Right:* Pottery that escaped the "killing"

Gold from the richest burial—four repoussé plaques, averaging eight inches in diameter; also, cuffs, sequins, and crocodile

A.D. Apparently burial was a rite reserved for chiefs, and with them were buried other persons—servants, slaves, and possibly even wives to accompany their masters to the spirit world. These seem to have been first stupefied, perhaps by quantities of chicha, the native beer still made today, and buried alive. In accord with the primitive feeling that mortuary objects also had to be "killed" in order to release their spirits to accompany the dead, almost all the pottery vessels had been shattered, probably by trampling. In many of the graves are large empty spaces which may have been occupied by baskets and such perishable objects of organic materials. Due to the constant dampness of the soil, only objects of pottery, stone, and metal were well preserved. Those of bone and ivory had to be excavated with the greatest of care, and wood and textiles were entirely gone. All the human bones were in too soft a condition to be saved. Relatively few intact pottery vessels were found, but more than three tons of pottery were brought to Philadelphia. As most of the parts of a broken vessel lay together, the task of restoring them is not a difficult one.

ONE grave far exceeded all the others in importance and "richness." Though most graves are flat or slightly concave, this one was cup-shaped. Apparently so many pottery vessels were made for the dead that they could not be placed on the bottom of the grave and so were imbedded in the almost vertical walls. From the edge of the rim, found at about five feet below the present surface, the grave extended down seven feet, the bottom being only one foot above water level, which was 13 feet below the surface at the height of the dry season. At the rim, the diameter was 14 feet; at the bottom, eight feet, making the average slope of the pottery-encrusted sides 60 degrees. Three interment levels were found, the main middle one at a depth of six feet below the rim, a lower level one foot lower, and an upper level 18 inches above. There were eight skeletons on the upper level, 12 on the middle one, and three on the lower—a total of 23. All lay parallel, east to west, face down, and those on the middle level in two tiers. Little grave furniture accompanied the interments on the upper level, as its occupants probably had been slaves or servants, but the lower levels were thick with broken pottery, and most of the skeletons bore some gold ornaments. One of those on the middle level, perhaps the principal chief, fairly blazed with a wealth of gold ornament. He wore five great gold plaques, gold cuffs and armlets, several gold pendants, ear-rods, nose-clips, many sequins, small bells and chisels, and quantities of beads.

The gold is heavy and almost pure. Every archeologist gets a great "kick" from digging up pure gold, as it is untarnished and appears in its pristine beauty as soon as the dirt is washed off. Eight great plaques, ornamented with demoniacal designs in repoussé, were secured; these are from eight to ten inches in diameter. The decorations apparently represent the native gods, a crocodile god being especially prominent. Cuffs and some other ornaments were also decorated in repoussé, probably hammered over forms. Most of the jewelry, however, was apparently made by casting, possibly by the lost-wax process. The most spectacular piece is a gold crocodile four inches long, with a large but poor-grade emerald, an inch in diameter, set in his back; the gem may have come from Colombia. Some of the gold pendants are exquisite examples of both technique and art.

By both quantity and quality this "find" was one of the richest, if not the richest, ever made in America by a scientific expedition from the United States. About 92 troy ounces of gold were brought back, in addition to the share taken by the owner of the land. In all likelihood the gold was panned in the local rivers, though today they do not yield enough to make mining profitable. The technique of gold working was a relatively late one in pre-Columbian America: gold was practically an unknown metal to the ancient Maya, for example.

THE pottery is profusely decorated in polychrome colors in which blue and purple, rare colors in other regions, predominate. The shapes are widely varied, from simple silhouettes to complex animal effigies. Objects of stone, mainly celts, spearheads, arrowheads, and agate pendants, but also larger objects, such as metates and mullers, were found in the graves and caches. Necklaces of the teeth of animals are common, as are also spines of the sting ray.

The aboriginal inhabitants of Coclé are almost unknown to history except for the short accounts of the Spanish chroniclers. Today no Indians live in this region, but the Guaymí of western Panama probably are their nearest relatives. The skeletal remains indicate that they were a large people, many of the men over six feet in height. They have no connection with and little resemblance to the Aztecs, Mayas, or Incas; indeed, their objects differ decidedly from those of the Chiriqui of western Panama and even from those of Veraguas, the next province to the west. What little resemblances there are to other cultures seem to point to the southeast, toward Colombia.

High Pressures Within

How Astronomers Derive Such Stupendous Internal Pressures for Earth and Stars

HENRY NORRIS RUSSELL, Ph.D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

A CORRESPONDENT suggests some questions which many others have doubtless asked in their own minds. How do astronomers arrive at the huge values which they give for the pressure at the center of the Earth, and still more of the Sun? Can we trust our methods of calculations to hold good when extended so far beyond the range of experiment?

The answer to the first question, under engineering conditions, is very simple. For a theoretical column (pipe) of imaginary liquid of the same density as water, and which was incompressible, it would come out, by arithmetical calculation, at 4550 tons per square inch. But this is too easy. Successively deeper miles of our pipe would contain equal quantities of fluid, but these would not all have the same *weight*, for the force of gravity inside the Earth diminishes toward the center—where attractions in all directions balance, and there is no net effect. At intermediate depths, Newton showed long ago that (for a spherical distribution of matter) the attraction of parts more distant from the center than the point considered, and forming a shell surrounding it, annul one another completely; so that the actual effect is the same as it would be if these were stripped off, leaving only the portion nearer the center. It follows very simply that, inside a body of uniform density, the force of gravity is proportional to the distance from the center. The average force acting on the fluid in our pipe would then be just half that at the surface, and the pressure at the bottom would be 2275 tons per square inch.

Let us come one step nearer reality by assuming that the density of our imaginary fluid was equal to the mean density of the Earth (5.56 times that of water). We then get a central pressure of 12,700 tons per square inch. The actual pressure must be greater, for the density of our planet increases toward its center—since the density of the surface rocks (omitting the thin surface layer of granite) is about 55 percent of the mean: the density at the center is probably nearly twice the mean. We can get a good general idea of the degree of central condensation, though not of the detailed form, from the relation between the polar flattening of the Earth and the centrifugal force due to its rotation.

If we knew the exact law of distribution of density, we could work out the pressure exactly. Starting at the center, and imagining successive spherical layers to be put on, each with the proper density, it is easy to find the total mass of any concentric sphere interior to the Earth, and hence the force of gravity at its surface—that is, at any given distance from the center. Then, starting at the surface and working downward, we find the weight of each successive mile of fluid in our imaginary pipe—supposing it, of course, now to have the density appropriate to its distance from the center. The cumulative sums will give us the pressure at successive depths, and finally at the center. (The reader familiar with the calculus will realize that the above is a "painless" description of a double integration!)

PERFORMING this calculation for the Earth, we find that the central pressure is about 50 percent greater than it would be if the planet were homogeneous. The outstanding uncertainties in the exact law of increase of density do not alter this conclusion seriously. We thus conclude that the actual pressure at the Earth's center is about 19,000 tons per square inch, or some 2,600,000 atmospheres.

At this point the reader may protest: "This is all very well for a pipe full of liquid, or a liquid planet; but the Earth is made of solid rocks. Won't it act like a set of great concentric arches, and hold up the pressure?"

For a small body, like an asteroid, this argument would be valid. On Earth, even if the material inside were cold, a pressure would be reached, at a depth of a few hundred miles, under which the hardest rocks would give, and flow not like water, but slowly, like pitch. Farther inside, where the pressures were still greater, the material, under long continued pressure, would show no permanent resistance, and behave like a very viscous liquid. We are therefore fully justified in maintaining that there is a real pressure, at the center of the Earth, of roughly 20,000 tons, or 40,000,000 pounds, per square inch.

WHAT happens inside the Sun? Here there can be no doubt that all of the material is fluid—indeed gaseous—with not a trace of rigidity.

If the Sun were built on a similar density-model to the Earth, the answer would be very simple. Reasoning of the type already described shows that, for the spheres built on the same model, the central pressure is proportional to the product of the square of the radius and the square of the density. The Sun's radius is 109 times the Earth's, and its density very nearly one fourth of the Earth's; so that, on this model, the central pressure would be $(109 \times \frac{1}{4})^2$ or 745 times that on the Earth—that is 14,000,000 tons per square inch.

But there is no reason to suppose that the Sun is built on this model (with the central density less than twice the mean), and very good reasons for believing that it is not. There are some pairs of eclipsing stars in which slow changes in the orbits make it possible to show that the central density is 50, or even 100, times the mean density. Inside such a body the attracting portions are, on the average, much closer together and the gravitational forces greater, so that the central pressure is much larger.

To get any reliable notion of how great the central density is within the Sun, we must have recourse to theory, and an important calculation has just been published by

four investigators. Two of these, Messrs. Lowan and Blanch, are in charge of a W.P.A. project for the computation of mathematical tables, a project which has already done excellent work in other fields; the others, Messrs. Marshak and Bethe, are well-known authorities on subatomic and stellar energy.

The principles on which their work is based are these: We have strong reasons to believe that the nuclear transformations by which the Sun's heat is maintained run so much faster with increasing temperature that practically the whole energy-liberation occurs in the hottest and densest part of the Sun, near its center; the rest of the Sun acts only as a nearly opaque envelope, which keeps the heat from escaping to the surface faster than it does. To drive this flow of heat through these outer portions, there must be a steady rise of temperature inward, and the envelope thus keeps the inner core hot enough to allow the atomic transformations to continue.

Since no heat is generated in the envelope, the total amount flowing outward through a sphere at any depth below the surface is the same as that which escapes from the surface itself, and hence a known quantity. The flow per square centimeter increases inward, since the spheres are of smaller area, but can be calculated at any point.

Now atomic physics has progressed far enough to enable us to calculate what temperature gradient is required to drive any given flow of heat through a gas of specified density, temperature, and composition. So (assuming a fixed composition), if we know the temperature and pressure at any depth, we can find the increase of temperature in the next thousand kilometers, for example—this being but a small fraction of the size of the Sun. We can also calculate the increase in pressure in 1000 kilometers, if we know the density of the gas (which depends on its temperature and pressure) and the force of gravity.

To calculate the latter, we must know how much of the Sun's mass lies farther from the center than the region where we are working. But the density of the outer gases is so small that, for 50,000 miles or so below the surface, we can safely ignore this correction. Under these simplified conditions it is possible to solve the equations, and derive formulas which give the temperature, pressure, and density at any depth, if we know the size and mass of the Sun, and the rate of heat-flow into space from its surface. This gives a good start for the calculation. When it has gone deep enough to "shed off," so to speak, as much as 1/1000 of the Sun's whole mass, account must be taken of this fact, and the "closed" formulas have to be replaced by a process of step-by-step numerical calculation of the changes in each successive layer. This is highly laborious, but may be made as accurate as is wished, by taking the trouble.

This process, however, cannot be carried right down to the center of the Sun, for the assumption that all the Sun's heat is generated "still deeper" becomes obviously absurd close to the center, say within 10,000 miles of it. Fortunately there is a simple way out of this difficulty. The calculated temperature gradient increases steadily toward the center. Now, in any mass of gas, something happens if the temperature gradient is too high, which is illustrated by the familiar "thunder-heads" of summer clouds. The air is warmer near the ground than, say, a mile above. "Warm air tends to rise"; but, if a mass of the warm surface air could be rapidly raised a mile high, and so be exposed to lower pressure, it would cool itself by expansion. Under ordinary conditions, this cooling would be great enough to make it cooler than the undisturbed air a mile up. Being cooler, at the same pressure, it would be denser, and would sink back again. But, if the air near the ground is very much heated, it may reach a state in which, after rising a mile and expanding, it would still be hotter than the surrounding air and tend to rise still higher. Under these conditions our ascending column of air, once started in any way, will rise higher and higher, and draw more and more of the hot surface air into it, until the latter is exhausted; but under normal circumstances a column set ascending would soon sink back, and conditions would be stable.

The same principle applies inside the Sun. So long as the vertical change of temperature is not too rapid, the cooler gases above will lie upon the hotter layers below in stable equilibrium; but, when a certain limit is exceeded, the lower layers will tend to rise, and the upper ones to sink, and a turbulent set of currents will be set up. With gases like those inside the Sun (in which all molecules have been broken up), this limiting condition happens when the percentage increase in temperature is more than 2/5 of the percentage increase in pressure.

The calculations for the Sun show that near the surface this ratio is much smaller than 2/5, but increases, and ultimately reaches this value. Nearer the center, the radiative equilibrium, in which the heat is carried by radiation through the gas, breaks down, and is replaced by convective equilibrium, in which heat is carried by bodily motion of ascending currents of gas.

A gas under these conditions, if considered on a scale large in comparison with the size of the individual eddies of current, presents a relatively simple mathematical problem, and can be easily handled no matter in what part of it the heat is produced.

According to the final calculations, at a depth of one-sixth of the Sun's radius the temperature is 1,070,000 degrees and the density only 1/220 that of water, or 3½ times that of air under standard conditions. Halfway to the center, the temperature is 5¼ million degrees and the density 92 percent that of water, while 95 percent of the Sun's mass is still inside. Three quarters of the way down the temperature is nearly 13,000,000 degrees and the density 24.6 times that of water. The inner core, in which convective currents occur, has a radius only 12 percent that of the outer surface and contains 12 percent of the Sun's mass. The central temperature is 25,700,000 degrees and the density 110 times that of water, or 78 times the mean for the whole Sun. The corresponding pressure comes out 1,700,000,000 tons per square inch. The concentration of matter into a small central region gives so strong a grip to the gravitational forces that this is more than a hundred times as great as it would be if the Sun was built like the Earth. Calculation of the liberation of energy by the now well-known carbon-nitrogen cycle shows that 97½ percent of the heat production would occur in the inner core. The approximation which supposes that it all takes place there is, therefore, a good one.

A Bridge Because of a Dam

Truss Design and Material Used Represent New Departures From Previous Practice

F. W. PENHORST
Bridge Engineer

COMPLETION recently of the Sacramento River bridge at Antler, in Shasta County, California, marks an important step in the fulfillment of the task of relocating approximately 16 miles of state highway in the Sacramento, Pit, and McCloud River canyons made necessary by the construction of the Shasta Dam near Kennett. A combination highway and railroad bridge across the Pit River is scheduled for completion next Spring.

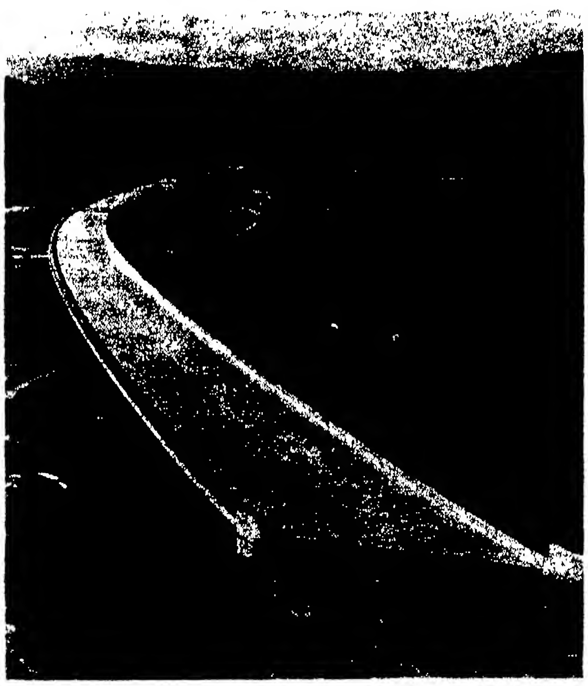
The Antler Bridge is a steel deck structure, 1330 feet in length, on concrete piers and abutments. The roadway is on a 5000-foot radius curve compounding into an 850-foot radius curve about 80 feet north of the south abutment. The entire structure is on a descending vertical curve of —2.5 percent grade at the south end and a —4.25 percent at the north end. The roadway width is 50 feet; two 2½-foot sidewalks are provided.

There are five major spans in the bridge; two of 189 feet, two of 252 feet, and the central span, which is 273 feet long. The 273-foot span consists of a 147-foot truss supported by two 63-foot cantilever arms. A steel stringer approach span at each end of the structure is supported by the abutment and by a 42-foot cantilever arm.

The pier heights vary considerably, the tallest being 172 feet above footing grade. The piers are eight feet wide by 40 feet long at the top and the sides are battered ¼-inch per foot to provide a pleasing appearance.

They are of cellular construction. using 18-inch walls and interior ribs throughout. Varying amounts of reinforcing steel in these walls provide for the differences in stress at the proper points. All piers are founded on rock.

Three of the piers extend down below river level and required concrete foundations poured under water. Construction joints are provided in the pier shafts at 20-foot intervals, a horizontal distribution girder, or "floor," being located at these points.



Roadway is on a 5000-foot radius curve

As the ultimate water level in the Shasta Reservoir will practically submerge the main piers, openings are provided at various points in the pier walls and floors to permit the free passage of water. This procedure not only eliminates hydrostatic pressure on the pier walls but adds considerable "mass" or "inertia due to weight of fluid" to resist earthquake forces, discussed later.

Next to structural safety, a fundamental requirement, smooth deck surfaces and good railing appearance are probably the two most important bridge factors to the motorist. Considerable care was taken, therefore, to insure good results in the completed structure, as follows:

(1) A railing and gutter profile was established for each side of the bridge, using long 1400-foot vertical curves to give a smooth change of super-elevation over the structure to fit approach alignment.

(2) Truss deflections due to full dead load were carefully computed, and elevations determined for each truss panel point to fit an "unloaded" profile. This "unloaded" profile is the final profile, plus the anticipated deflection under dead load.

(3) The fabricating shop sub-punched, or sub-drilled, all main truss connections, then completely assembled each truss in a horizontal position in the shop, placing each top chord panel point in its correct relative position to fit the "unloaded" profile.

(4) All truss joints were then reamed to full size, and all members match-marked for erection.

(5) Trusses were then erected at the bridge site in any desired order as correct position was secured simply by jacking the trusses into shape until all truss connections were fair. No field drilling of these connections was allowed.

(6) The concrete deck was then poured to suit the contractor's working schedule. This was an important feature, as pouring a deck slab uniformly from one end of a structure to the other is much less costly than requiring short individual pours over various parts of the bridge.

To prevent participation of the concrete deck slap in resisting stress set up in the trusses by the weight of the slab, as it would surely do if rigidly attached, the deck has been literally "cut loose" by introducing small expansion joints in the stringers approximately 100 feet apart. This is of no consequence to actual strength of truss members, but has a pronounced effect upon deflection of the trusses. As accurate truss-deflections can be determined only if the slab is prevented from taking direct stress, this procedure is essential to secure a smooth deck

It is most important in constructing a concrete deck to anticipate accurately the deformation of the various members involved, as cor-

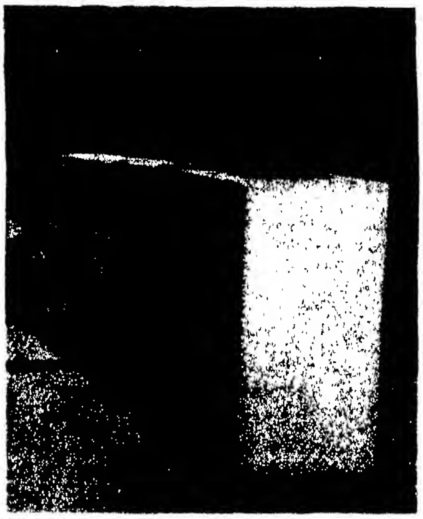
recting a rough or wavy deck after construction is a difficult and costly process.

To eliminate deflection stresses from the piers, temporary expansion rollers were used at the tops of all piers. Upon completion of the deck slab and upon a suitable day of average temperature, the truss shoes were grouted into permanent position.

Piers were arranged so that those on either side of the central span are supported longitudinally by anchor piers of comparatively low height located high up on the canyon walls. A suspended span in the central 273-foot span, with provision for expansion at one end, establishes a symmetrical truss layout, continuous over three supports on each side of this span. Trusses are then fully "indeterminate" only over the center support of the group, the "degree of indeterminacy" diminishing toward the two outer supports of the group, becoming fully "determinate" at these supports and beyond.

IN ORDER to support the main piers in a longitudinal direction, the trusses were attached to the pier tops by a rotating type of joint that will transmit horizontal shear, but no bending movement. This is important, as a rigid type of connection would practically double the temperature stresses in trusses and piers set up by horizontal deflection of the piers.

Transversely, the four high piers must provide their own stability. No temperature stresses exist in this direction, but wind and earthquake forces are quite severe. Analysis of the effect of "wave action" of the reservoir water due to earthquake forces was made. This "wave action" effect refers to the oscillating motion set up by an earthquake, and should not be confused with surface "waves" due to wind or tide. Extensive research and model experimentation has been done in this field by the United States Reclamation Bureau



Rotating joint, no bending

at Denver, Colorado, and use was made of these studies on this job.

Trusses were bent horizontally at two points between each pier rather than at the piers, to fit the horizontal curve of the bridge. A number of advantages result from this:

(1) The eccentricity, or overhang, of deck stringers relative to the trusses is but one-fourth that produced by bending the trusses only at the piers. This eliminated additional steel in the floorbeams located between bend lines.

(2) Bending moment in the truss is very low at the bend line due to the continuous truss layout. These bend lines occur at approximately the quarter points in the span where the dead load moments are practically zero.

Truss joint stresses are correspondingly low, and the torque resulting from these stresses is greatly reduced. While it is true that the torsional stresses set up at the bend lines must be transferred along the trusses to the piers, stresses are so low as to require no additional metal in the main trusses to resist them.

A newly developed alloy steel used in the trusses has 50 percent greater tensile strength than and is five times as rust resisting as ordinary structural steel. Its excellent corrosive resistance permitted minimum sections of 1/4-inch thickness, while the additional strength available resulted in large savings in weight of metal.

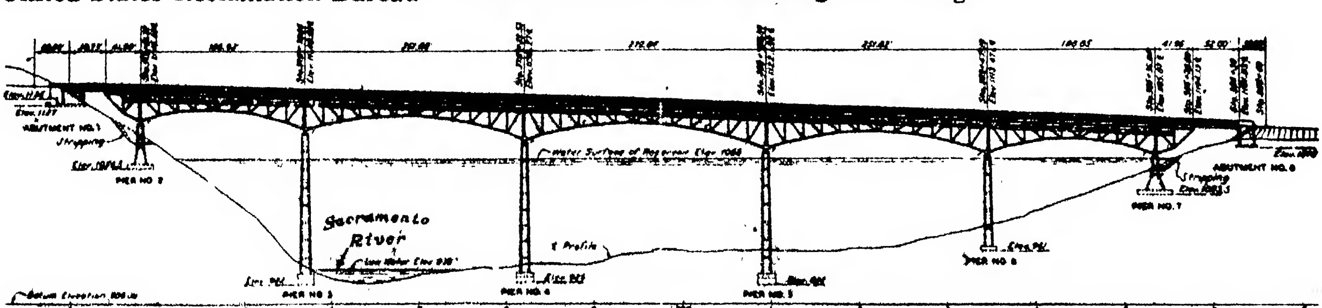
The truss member design represents a considerable departure from previous construction. All members consist of a 14-inch beam section, supplemented when necessary on the compression members with 15-inch or 18-inch channel sections shop welded to the beam flanges. No stay plates or lacing bars, formerly considered indispensable to truss members, were used. This not only reduces shop fabrication, but eliminates excess metal not directly participating in stress resistance.

AS TRUSS members are perfectly smooth and accessible for painting, maintenance costs will be materially reduced.

Bracing members were made from structural tee sections obtained by splitting wide flange beam sections at the rolling mill when hot. These sections became available fairly recently and have proved very economical.

Truss-shoes are built-up assemblies of rolled steel plate, shop-welded together to form a rigid unit. Alloy steel was used, resulting in a strength and ductility equal to that secured in the main truss. The largest truss shoe is approximately five feet square by 2½ feet high, and supports a load of more than 2,000,000 pounds.

Temperature variations of 20 to 120 degrees, Fahrenheit, produce a total movement of nine inches at the one expansion joint in the truss system. A sliding "finger" type of joint was used in the deck slab, featured by a locking device that anchors it rigidly to the deck to prevent noise and vibration due to passing vehicles. The joint is self-cleaning, in that rubbish and dirt cannot collect in the openings, but are pushed off by movement of the bridge.



Illustrations and text courtesy California Highways and Public Works

The four high piers must supply their own stability transversely

International Beams

Short-Wave Broadcasts, Directed to Foreign Countries, are "Searchlighted" for Power

RAYMOND F. GUY

Radio Facilities Engineer
National Broadcasting Co., Inc.

DESPITE the fact that heavy penalties are meted out to residents of certain oppressed European countries who are detected in the act of listening to broadcasts from American radio stations, there is ample evidence that a substantial radio audience exists in those areas. Letters received in the United States, often by roundabout means, convey with stirring impact the value of the international broadcasting service which has been available for several years past.

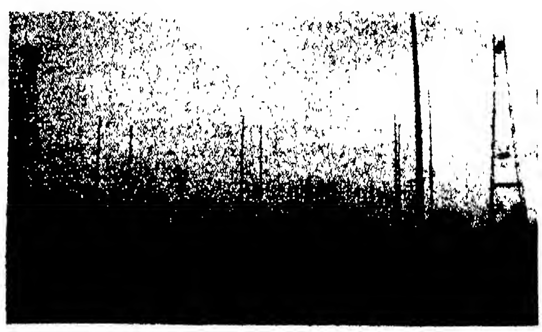
One cannot help but be deeply impressed by many of these communications from Europe, expressing as they do despair and misery which to some extent is lightened by the medium of radio broadcasting. Neither can one read the pleas to continue and expand our broadcasting efforts without more fully appreciating the high patriotic and humanitarian function which is being served by short-wave licensees in the United States. International broadcasting, as conducted by the democracies, has become a powerful instrument which has earned the respect and confidence of foreign listeners through the truthfulness of its reporting and the character of its programs.

Then, too, there are the Americas to the south of us, where news, educational, and entertainment broadcasts are eagerly sought by an audience that is highly receptive to the influences of the unbiased and complete coverage of these transmissions from the United States.

International broadcasts by NBC originate at the Bound Brook, New Jersey, plant where also are located the transmitting facilities of WJZ. A tract of 70 acres is largely devoted to the special antennas which have been designed for transmission to Europe and Central and South America over stations WRCA and WNBI.

IMPORTANT among the developments which have made possible consistent broadcasting to far-distant countries is the beam or directional antenna. With this system it is possible to direct a fan-shaped beam of radio energy instead of broadcasting it to the four winds. The beam antenna thus represents concentrated power, in much the same manner as a search-light beam represents concentrated light. The gain in power through the use of a beam antenna is outstanding. For example, a specific directed antenna used with a 50,000-watt transmitter produces an effective power of 1,200,000 watts. This simplified statement means that if the energy were broadcast in the conventional manner, instead of being sent out through a beam antenna, a 1,200,000-watt transmitter would be needed to achieve the same signal strength at distant points as is now produced by a 50,000-watt station. And the engineers have another trick up their sleeves. When necessary, the two 50,000-watt transmitters at Bound Brook may be synchronized on the same wavelength to get even more effective coverage at very distant points. When this is done the effective power resulting from the combination, feeding a beam antenna, is the equivalent of 1,700,000 watts.

In the design of a beam antenna it is possible to control the width of the beam, but the engineer must decide on the desirable compromise between power gain and beam width; one, of course, is obtained at the expense of the other. Thus a beam broad enough to cover all of South America would have such low power gain that it would not provide sufficient signal intensity at the receivers to give satisfactory service. On the other hand, it would be a comparatively simple matter to increase the power gain by narrowing the width of the beam. This, however, would result in greater signal strength over a limited area at the sacrifice of service to adjoining areas of importance. Thus, to insure satisfactory field intensity to South America, two antennas must be used for each frequency, while a third antenna is required to cover Central America. European service, of course requires another array of antennas.



Above: **Close-up view of the steerable antenna used in serving Rio de Janeiro and Buenos Aires areas from the United States.** *Left:* **General view of short-wave antennas at Bound Brook, New Jersey. At extreme left is the steerable antenna shown above. Other arrays are for South American services on other frequency bands**

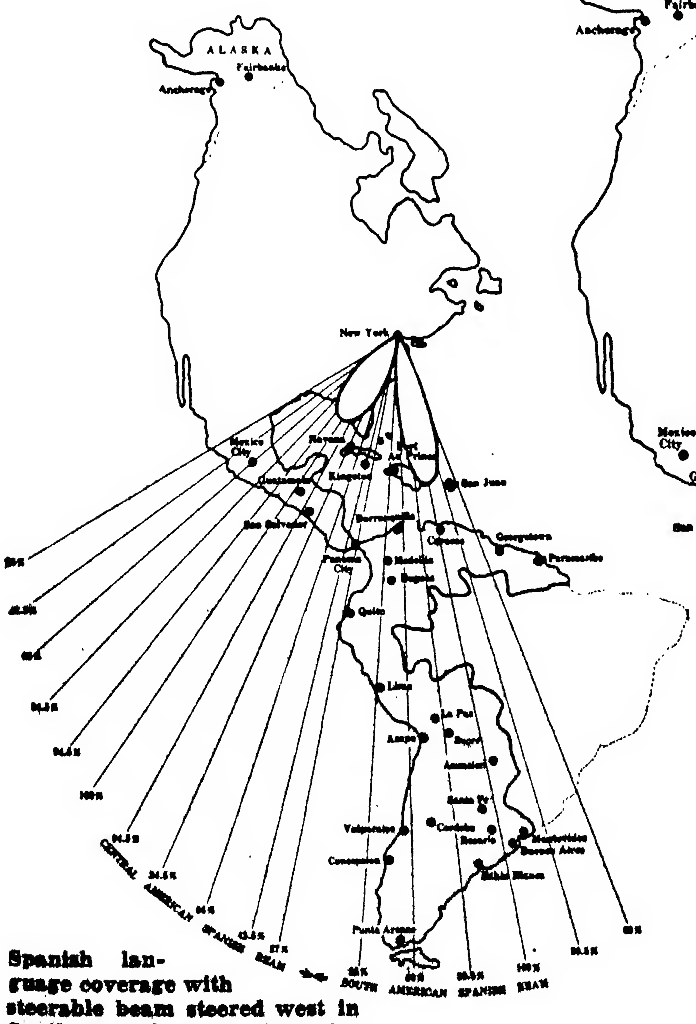
Another form of aerial which is being used in international broadcasting is the steerable beam antenna, developed by NBC engineers. One of these has been in daily service for some years and another one is now nearing completion. By the use of a suitable electrical system and three groups of antennas, the beam can be steered in such a manner as to place the greatest signal intensity at the receiving end in the area which it is desired to cover at the moment. The technical details of the steerable antenna are somewhat involved; essentially, the result is achieved by throwing two of the three antenna circuits out of phase with respect to the third. Complicated as is the action, it is controlled from a single switch. When this switch is operated, the beam is steered ten degrees to one side or the other of the center line.

The steerable antenna is of the greatest value in serving the areas centering around Rio de Janeiro and Buenos Aires. These two areas, as viewed from New York, are 20 degrees apart and are the most important language areas of South America. A beam sufficiently wide to cover these two localities would not be as effective in power gain as the steerable beam which permits more satisfactory service and higher signal intensity.

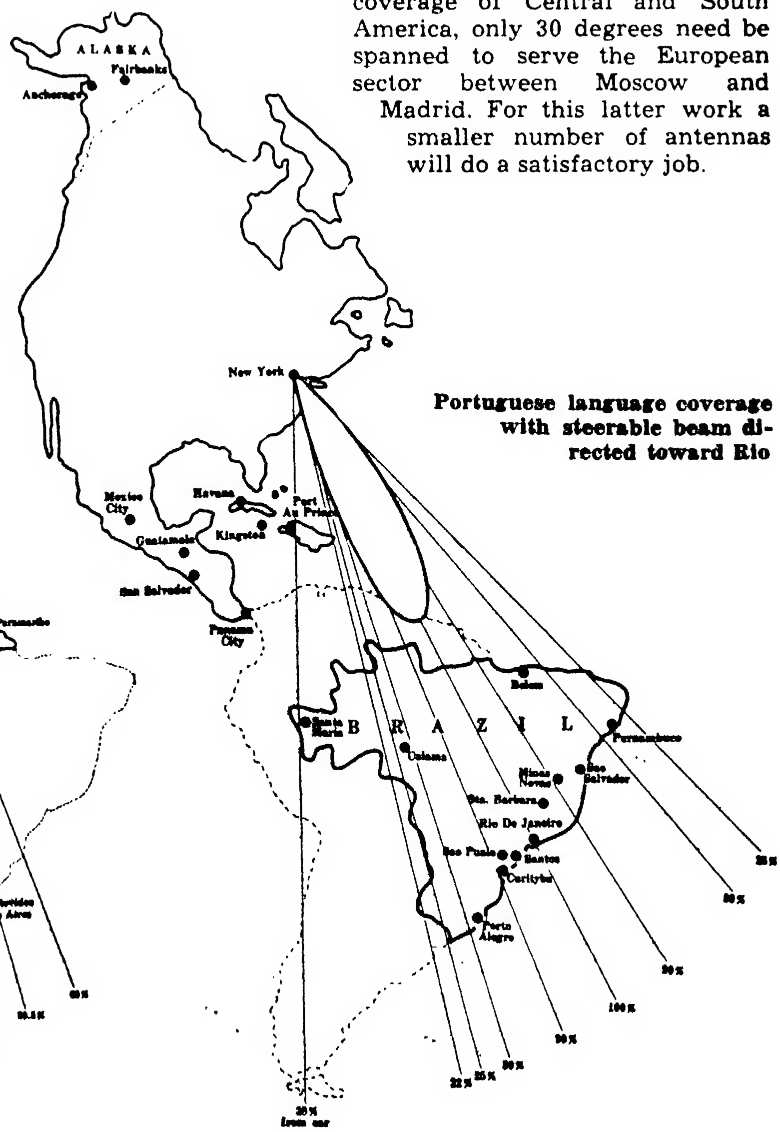
Mr. Guy, author of the present article, at an instrument panel

Brazil is unique among Latin-American countries in that it is the only one having Portugese as its native language. Throughout the balance of South America and in Central America the native language is Spanish. Obviously, listeners in Brazil speaking Portugese are little interested in programs transmitted in Spanish, English, or other languages. Similarly, in other parts of South America and in Central America, people speaking Spanish have little interest in programs in other languages. Hence the necessity for individual antennas and the use of the steerable beam to provide a satisfactory and consistent service to all areas concerned.

In the case of international broadcasting to Europe, there is not such a wide spread for the beam to cover. While 100 degrees of arc must be considered for coverage of Central and South America, only 30 degrees need be spanned to serve the European sector between Moscow and Madrid. For this latter work a smaller number of antennas will do a satisfactory job.



Spanish language coverage with steerable beam steered west in South America, showing also coverage of Central America



Portuguese language coverage with steerable beam directed toward Rio

A single motion of this switch directs the steerable radio beam

As has been noted before, relatively narrow beams are used for serving the South American area, utilizing the steerable beam to obtain flexibility. In the case of transmissions to Central America, however, the antenna has been designed to emit a beam which will cover an arc of 50 degrees. Here, of course, the power gain is lower than in the case of the South American beams, but the net result is satisfactory because Central America is comparatively close to the transmitter at Bound Brook.

It is impossible to give an accurate estimate of the number of radio receiving sets in Europe which are served by international broadcasts from the United States. In South America, however, it is possible to tabulate the receivers in use and the resulting figures give a graphic picture of the importance of international broadcasts to residents of the southern Americas. Present statistics give the number of radio sets in some of the Latin-American countries as follows: Argentina, 1,050,000; Brazil, 500,000; Mexico, 300,000; Chile, 160,000; Uruguay, 150,000; Venezuela, 138,000; Colombia, 100,000; Peru, 68,000; Panama, 24,000; Guatemala, 21,700; and all other Latin-American countries below the last number. The service which is now being rendered by the international broadcasting system of National Broadcasting Company involves a minimum of 16 transmitter hours per day directed to Europe during the most favorable listening periods on that continent. About 18 transmitter hours of service are devoted to Central American and to the Spanish and Portugese areas of South America during those hours when listening conditions are at their best. At times the transmitter service is continued on both stations for 24 hours a day. A growing proportion of the program material consists of unbiased news broadcasts which are brought to the attention of foreign listeners with the aid of institutional sponsors and, especially to Europe, through the efforts of the National Broadcasting Company itself.

Rarely has there been an opportunity within the past decade for any form of communication to demonstrate such unique feats as are now becoming accepted commonplaces in international broadcasting. Barely sixteen years ago the first rebroadcast from across the seas took place. Scheduled broadcasts from the far corners of the earth have since become matters of but casual interest. But only in recent months has the bewildered victim of catastrophe, propaganda, and censorship so fully appreciated the modern miracle of radio which enables him to listen, perhaps secretly, to free stations thousands of miles overseas for frequent and authoritative reports of world events, at times taking place in his own country, frequently at nearby points.

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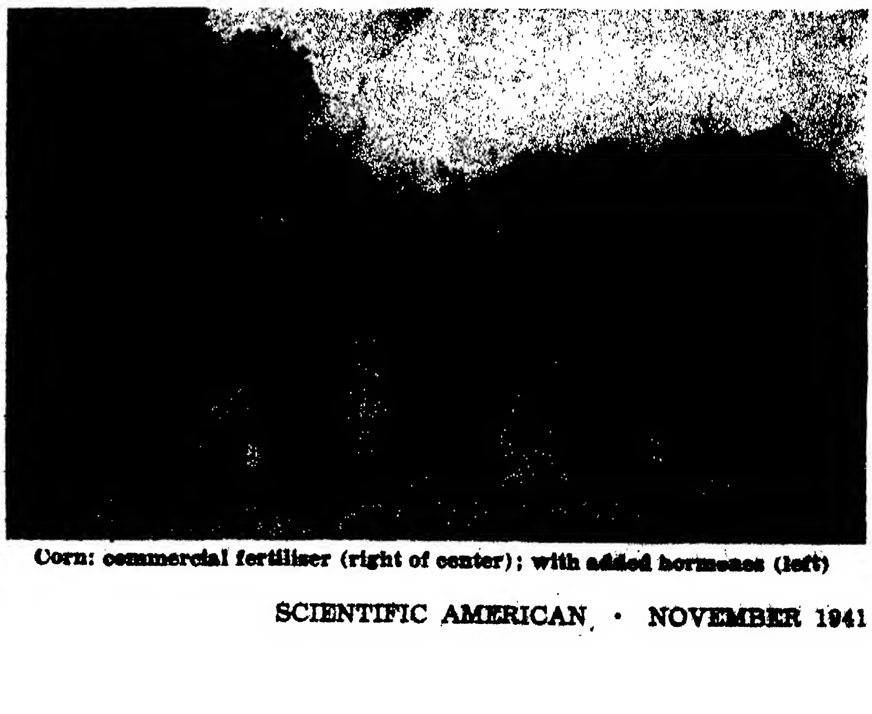
Hormones for Plant Growth

Stabilized Organic Compounds in Commercial Fertilizers Give Added Stimulation

Goal of plant growers for many years has been the development of substances that, applied to the growing plant, will not only provide that plant with the necessary food elements that may be lacking in the soil but will also result in increased root and plant development. Described in these pages in the September 1940 issue were laboratory experiments with a variety of hormone-like substances known as auxins. These are organic compounds, some 50 of which are known to contribute to the desired results, the most common and desirable belonging to the fatty acid group.

At the time this report was published, the experimental work was being carried out on a laboratory scale, with results that appeared to be worth following up. One experimenter, Lionel Weil, a commercial fertilizer manufacturer, started to investigate this intriguing field in order to determine whether the laboratory results could be transferred to large-scale practice on the farm. In early experiments he attempted various means of mixing the auxins with commercial fertilizers and applying the mixture to field crops in the conventional manner.

Results obtained were at first unsatisfactory, in that the combination failed to produce crops that showed any noticeable improvement over those to which



Corn: commercial fertilizer (right of center); with added hormones (left)

commercial fertilizer, less the auxins, was applied. Further investigation and consultation with the Boyce Thompson Institute revealed that the auxins were relatively unstable under field conditions where they were subjected to the actions of sunlight and weather.

Additional experimental work, directed always toward the end of increased crop production from a given acreage, served to overcome this disadvantage of instability of the organic compounds used. Briefly stated, this was accomplished by

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"DARCY": Petroleum engineers have applied the term darcy to their work, the word being used to designate a unit for measuring the permeability of porous rock thousands of feet underground. One darcy means that rock, under conditions of viscous flow, will pass one milliliter per second of a fluid having a viscosity of one centipoise through a one square centimeter cross-section when a pressure gradient of one atmosphere per centimeter is applied.

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mixing the growth-stimulating auxins with a carrying agent and stabilizer formed of a ground or pulverized fibrous material such as peanut meal, peanut hulls, soy bean meal, fish meal, and so on. When the auxins are first dissolved in a suitable solvent and then mixed with the fibrous material, it is found that they can be further mixed with commercial fertilizers and applied in the ordinary manner. The auxins are then no longer unstable, retaining their ability to stimulate root and plant growth even under the adverse conditions found in agriculture and gardening.

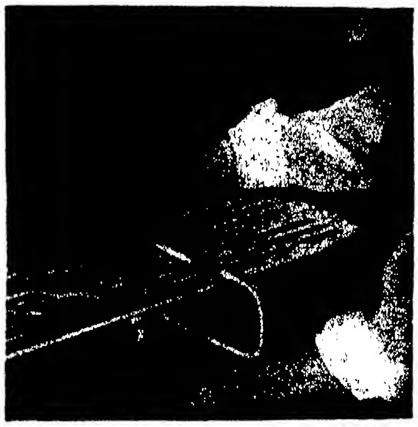
So powerful is the action of the auxins in this combination that the proportions used are on the order of 60 to 400 milligrams of the growth substance to a ton of commercial fertilizer, the most satisfactory results being obtained when a ton of fertilizer contains from 120 to 240 milligrams.

Favorable results with Hormo Fert, as the new fertilizer is called, have been found in the growing of snap beans, tobacco, corn, wheat, oats, and cotton. In experimental work with cotton growing, the new fertilizer produced 833 pounds of lint cotton to the acre—89 pounds more than an adjoining acre planted and cultivated in the same way but without auxins in the fertilizer. Furthermore, the auxins speeded up the rate of growth so that 93 percent of the seed cotton could be gathered in the first picking from the treated field; 84 percent was the rate from the controlled field. This factor of early picking is of importance to cotton growers as well as to growers of other agricultural products, as it makes it possible to reach an earlier and more profitable market with a maximum quantity of the product.

SAW

Large Capacity Electrically-Driven Scroll Saw

SCROLL sawing can be done on any length board up to 19 inches in width with the new Moto-Saw recently developed by the Dremel Manufacturing Company. This in-



Motorized

creased capacity has been made possible by the provision of additional slots in the blade holder which enable the operator to engage the saw blade at an angle of 90 degrees to the frame.

STREAMLINERS

Two-Car Units Designed For Mountain Service

RECENTLY placed in use on the Denver to Salt Lake City run, new streamlined trains of the Denver and Rio Grande Western Railroad consist of self-powered, stainless steel cars especially designed for heavy-duty work in the high altitudes encountered on the run.

Each of the two-car trains has a capacity of 62 passengers, operating power being supplied by horizontal Diesel engines suspended beneath each car. Thus the power plants do not occupy space in the car bodies themselves, providing additional capacity for passengers and baggage. Each of the four Hercules Diesels in the two-car units is rated at 192 horsepower at 1600 revolutions per minute. The trains were constructed by the Edward G. Budd Manufacturing Company.

PSYCHIC RESEARCH

• The Scientific American Committee for the Investigation of Psychic Phenomena has under consideration applications from several persons who claim psychic powers and who desire to demonstrate such powers before the Committee. When and if these, or other, applicants present spiritistic demonstrations at a meeting of the Committee in accordance with the rules and regulations announced in our April 1941 issue, a subsequent report will appear in these columns. As stated in our April issue, the sole purpose of the Universal Council for Psychic Research and of Scientific American in jointly posting the award of $15,000 is to offer incentive for cooperation by any person who may be able to assist the Scientific American's Committee on Psychic Research in its endeavor to discover a basic, truthful, scientific explanation of spiritistic phenomena. •

OIL HEATING

Economy With Increased Efficiency

EFFICIENT operation of the oil-fired, home-heating plant is of high importance this year both as a means of conserving oil and saving shipping space. Arthur H. Senner, mechanical engineer of the Bureau of Agricultural Chemistry and Engineering, reports observations indicating that firing an oil furnace at a high rate, even though the burning time may be shorter, is likely to be considerably more costly than firing at a lower rate. The results in this case are comparable to those often cited in teaching economy in the operation of automobiles, which use less gasoline per mile at 30 or 40 miles an hour than at 50 or 60.

Senner says that in a home heating plant for an 8-room house, assumed as an example, where the overall efficiency is 66 percent on a firing rate of one gallon an hour, the efficiency would drop to 63 percent if the rate were raised to 1.35 gallons an hour. If the oil were fed at 1.65 gallons an hour, the efficiency would go down to approximately 58 percent. The overall

efficiency means that fraction of the heating-value in the oil that is available for heating the house.

In bringing the different burning rates down to dollars and cents, Senner used an oil price of seven cents a gallon and an electric current cost (for the motor) of three cents a kilowatt hour. At the firing rate of one gallon an hour the gross cost for the season was $138, of which approximately $8 was for current. At the firing rate of 1.65 gallons an hour the gross cost was $153, of which approximately $6 was for current. At the higher burning rate the motor runs a shorter time and some money is saved on current, but the saving is more than balanced by oil cost. At these prices, burning at the higher rate would cost a net of $15 a season more. Where fuel prices are higher, the saving is greater.

This problem of rate firing, says Senner, is not for the householder to solve himself but one to be taken up with the oil burner service department.

VITAMIN TREES

Vitamin B_1 Found Concentrated in Buds of Trees

LARGE quantities of vitamin B_1, the "morale vitamin" which exercises a beneficial effect on the human nervous system, have been found in the buds and leaves of many common American trees, by Yale University botanists. The scientists found heavy concentrations of the substance in the buds of oak, red maple, horse chestnut, elm, sycamore, and white pine trees, according to *Science Service*.

"Although vitamin B_1 is now produced by synthetic chemical processes, this discovery points to a large natural source of vitamin B_1," stated Prof. Paul R. Burkholder. "This finding may offer a clue to the source of essential vitamins for many forest animals."

OCEAN WEATHER

Extending Facilities for Data Collection

RADIO sonde apparatus, which measures and records weather conditions at upper air levels as high as 12 miles, has been installed aboard the three ships of American Export Lines plying between New York and Lisbon, the *Exeter*, *Excambion*, and *Excalibur*. These are the only American flag ships operating between the United States and Europe on regular schedules at the present time, and the observations made from shipboard will provide the United States Weather Bureau with a wealth of meteorological data which has hitherto been unavailable.

Weather recording on shipboard

Equipment for the work was supplied by the Weather Bureau and installed by the steamship line. Special "weather shacks" have been built on the mooring bridges of the three ships. Trained meteorologists from American Export Airlines will be in charge of the equipment on trips, making observations twice daily and relaying their findings by radio to the Weather Bureau. Lieut. Commander Vernon Clapp, U.S.N. (Ret.), chief meteorologist of the airlines, is supervising the operation.

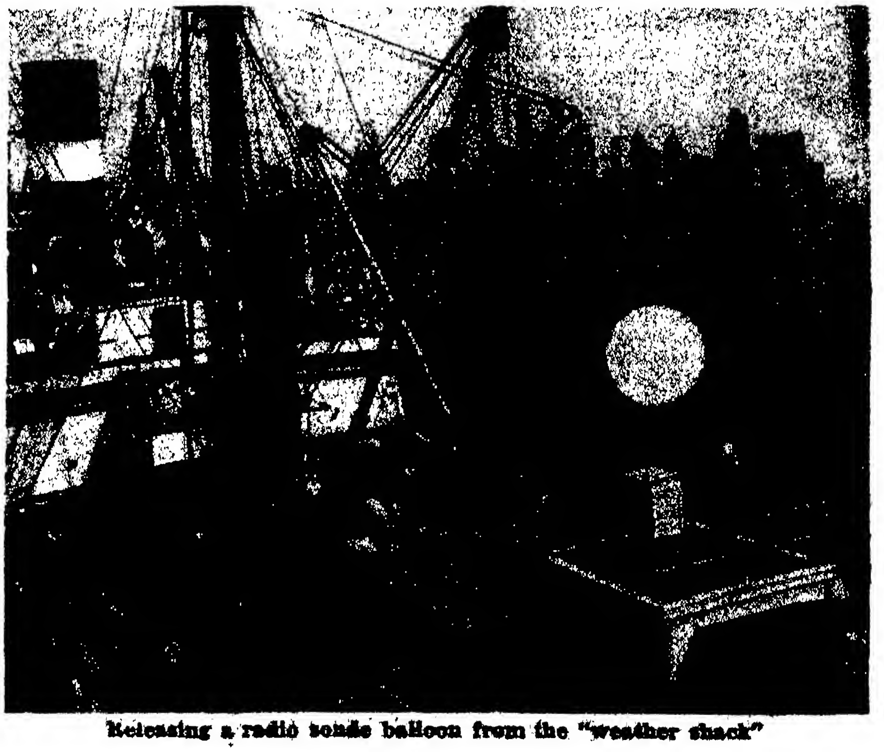
Helium-inflated rubber balloons, measuring about five feet in diameter and about six feet in depth, are used to carry the sounding equipment aloft. A light-weight radio transmitter, weighing about two pounds, is attached to the balloon. Inside the transmitting device is equipment for measuring temperature, humidity, and pressure at upper air levels.

Although similar soundings have been made over land by both the Navy and the Weather Bureau, and although some have been made by Coast Guard cutters, this installation is the first effort to obtain daily, regular reports all the way across the Atlantic on commercial ships.

HOT SHOVEL

Electric Heaters Prevent Damage by Cold

COLD-WEATHER damage to the big 30-yard stripping shovel of the Truax-Traer Coal Company has been largely eliminated by the use of General Electric Calrod heaters, which are expected to pay for themselves many times over out of savings. The main problem confronting the Truax-Traer Company was that the dipper handle of its big shovel sometimes snapped dur-



Releasing a radio sonde balloon from the "weather shack"


JOIN
AMERICAN RED CROSS

ing winter operation, as a result of the chilled condition of the metal. Each breakdown meant an expensive repair bill, plus the expense of idleness.

This danger has been averted to a considerable extent by the installation of twelve 2000-watt 230-volt heaters around the inner surface of the dipper handle. The heaters are fastened to the surface of the dipper handle in lines of four, one line being placed in the center of the bottom of the handle, and a similar line run along each side of the handle.

RUBBER: Present plans, according to the Department of Agriculture, call for the eventual establishment of 7500 acres of rubber plantations in the Republic of Haiti. Although no commercial rubber is grown in Haiti now, experiments indicate that the plan should eventually be successful.

Heaters were installed on the dipper itself, to solve another costly cold-weather problem. In cold weather, mud froze to the sides and bottom of the dipper, gradually accumulating until the payload of the dipper was reduced by 50 percent or more. Bonfires and a shutdown of 30 minutes to an hour were necessary to thaw out the accumulated mud.

To solve this problem, hotplates heated by Calrod heaters were welded on each side of the dipper, and on the center panel of the door. Another Calrod heater was formed in a circle around the manhole entrance to the dipper handle, where it joins the dipper.

Two natural-convection heaters, rated three kilowatts each, are mounted in the control cab of the shovel, keeping the cab at a comfortable temperature and thus protecting the health and efficiency of the operator.

AUTO STATIC

Eliminated by Powder in Inner Tubes

All radio static interference and static shock caused by the friction of rotating parts in motor cars, including wheels, fan belts, and tires, is eliminated by a powder which is blown into inner tubes, according to United States Rubber Company.

One tablespoon in each tube, where it remains in suspension like dust in the air, is sufficient to neutralize the static in any make of radio, with any kind of antenna, on any make of passenger car, with any make of tire or tube, on any type of road surface, it is claimed.

Application is made with the tires on the car. Tubes are deflated, valve cores removed, powder blown in with an applicator, and tubes inflated. Loss of powder in case of a puncture is so small that full effectiveness remains. The powder has been tested for many months both by the company's field service organization and by automobile manufacturers without one failure.

"Insulating" a tire

TERMITE PROOF

Chemically Treated Lumber Resists Invasion

A test house built on a Canal Zone island 15 years ago with chemically treated lumber continues to repel termite attack, report inspectors of the United States Bureau of Entomology in the latest issue of *Wood Preserving News.*

Because Barro Colorado island, Panama, is the most heavily infested termite area in North America, wood untreated with preservatives is devoured within a year.

In 1916, the American Wood Preservers' Association supplied yellow southern pine impregnated with zinc chloride to the Bureau of Entomology. Also furnished for the construction of the test house was a quantity of creosoted timbers to be used in the foundations and framework.

Since that time the building has been inspected at varying intervals. Although termites soon built so-called "shelter tubes" along supports reaching in some cases to the roof, it was stated that in no instance had they entered the treated wood. The shelter tubes leading from the underground homes of the pests—responsible for many millions of dollars worth of damage annually—were eventually abandoned.

"Bait stakes" of untreated wood placed underneath the house, were entirely consumed by termites.

Though the moist, hot, tropical climate of the Canal Zone is conducive to rapid wood rot, the Bureau reported its inspection of the test house shows the chemically treated timbers to be in perfect condition on this score as well.

FIBERS

Cotton Still Holds Its Own Fairly Well

Uses of fibers have been changing in the last half century, according to the United States Department of Agriculture, but statistical studies made recently by the Bureau of Agricultural Chemistry and Engineering at its Southern Regional Research Laboratory show that, by and large, cotton has been holding its percentage place fairly well. Cotton has done this in spite of the rise of new products.

Cotton has made up about 70 percent of the mill use of fibers in this country during the 50-year period, the quantity used shifting up and down with the shifts in the total of all fibers used.

Compared only with other apparel fibers—wool, silk, rayon, and flax—cotton made up 79.3 percent of the total in 1939, somewhat less than the average of 85.6 percent for the period 1920-29. On the other hand, rayon—for some kinds of which cotton is used as a raw material—made up only 1.6 percent of the total from 1920-29, but reached 10.1 percent by 1939.

CLEANED AIR

Will Protect Records of War Department

When printed records are kept in an atmosphere that contains a minimum of foreign matter, they are protected against deterioration and from becoming yellow and brittle. Such deterioration is largely due to the presence of sulphur particles in the air. Electrically cleaned air, therefore, will soon be used to protect government records

Books on Psychic Phenomena

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Extra-Sensory Perception After Sixty Years

By J. B. Rhine, J. G. Pratt, Burke M. Smith, Charles E. Stewart, and Joseph A. Greenwood

A COMPLETE account of the research conducted to date on extra-sensory perception. This book is a summary of what has been achieved so far, a reference work covering the field as a whole, a treatment of all the evidence, a guide to the literature of the subject, a condensation of the greater bulk of it, and a handbook of methods. It includes a digest of 56 articles of criticism of experiments in extra-sensory perception, mainly as made by psychologists, in which these are dealt with without emotion. A solid, serious study. (463 pages, illustrations.) —$2.85 postpaid.

Forty Years of Psychic Research

By Hamlin Garland

AFTER a lifetime spent in investigating spiritualistic phenomena, the author presented the facts as he observed them. He theorized little, witnessed without emotion, and after a clearly stated, factual presentation, he permits the reader to draw his own conclusions. (394 pages.)—$3.60 postpaid.

Cavalcade of the Supernatural

By Dr. Harold H. U. Cross

HIGHLY valued as one of the clearest, most convincing volumes dealing with manifestations all over the world of water divining, luminous effects, materializations, spirit photography. Illustrated with authentic pictures.—$2.10 postpaid.

Experiments in Psychics

By F. W. Warrick

INTENDED for experienced students of psychic phenomena, this book records the results of years of systematic investigation of direct writing and psychic photography. A large number of experiments, accompanied by photographic studies, all made under test conditions, seems, in view of the convincing nature of results, to rule out the possibility of fraud in the majority of cases and to offer strong evidence in favor of the types of psychic phenomena dealt with. (600 illustrations.)—$7.60 postpaid.

DUNNINGER

YOU, TOO

Can Investigate The

SUPERNATURAL

IN our April issue we announced our intention of exploring the realm of the psychic in an endeavor to determine whether, through mediums, we can communicate with the dead. We want to know if such things as phantoms, ghosts, spirits, or vampires actually visit us. We seek the facts concerning ectoplasmic and other supernatural demonstrations of a physical nature. To aid us in our search, the Scientific American Committee for the Investigation of Psychic Phenomena was formed under the chairmanship of Dunninger, whose world-wide reputation as a telepathist, magician, and psychic investigator is unequalled.

In the course of our search the Committee will welcome sincere and bona fide assistance. Should your interest in the psychic lead you to try to discover for yourself a basic, truthful, scientific explanation, you will wish to follow the reports of the Committee as they appear in ensuing issues of Scientific American. For correlative reading, the books listed on this page will be found informative, helpful, and interesting.

—The Editors

Books on Psychic Phenomena

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Inside the Medium's Cabinet

By Dunninger

A DARING exposé of trickery practiced by fraudulent mediums in presentation of so-called supernatural phenomena. In an exciting series of revelations, this internationally known authority on spiritistic matters divulges the secrets of certain mediumistic personalities who have come within the scope of his experience. Every statement of fact is based on the author's first-hand investigation. (228 pages, profusely illustrated.)—$2.60 postpaid.

Psychics and Mediums

By Gertrude Ogden Tubby

A MANUAL and bibliography for students, this is also an important guide and source book, presenting a scientific analysis of all types of psychic research, both objective and subjective. (210 pages.)—$2.10 postpaid.

Science and Psychical Phenomena

By G. N. M. Tyrrell

IF the world is to be saved from the advance of materialism, the author points out, knowledge of man's psychic processes must be extended. This splendidly informed, thoroughly scientific examination of a controversial but increasingly important subject is a unique addition to the literature on psychical research. Brilliantly concise, carefully evaluated, the history of research and the method of collective experiment are described. —$3.85 postpaid.

Beyond Normal Cognition

By Dr. John F. Thomas, Ph. D.

THIS is an intensely interesting study, evaluative and methodological, of the mental content of certain trance phenomena. The author was for some years associated with the Boston Society for Psychic Research. (319 pages, bound in cloth.) —$3.10 postpaid.

in the entire wing of the new United States War Department Building now under construction in Washington, D. C.

The air in the rooms where these records are kept will be cleaned by electrostatic air cleaners known as Precipitrons, developed by Westinghouse Electric and Manufacturing Company. More than 85 percent of all foreign particles will be removed from air entering the building at the rate of 500,000 cubic feet a minute.

It is authoritatively claimed that, although Washington is a relatively clean city, each cubic foot of its air contains hundreds of thousands of particles of smoke, soot, and dust. The larger particles may be removed with mechanical filters, but it is the smaller ones that do the real damage to walls, records, and clothing. Electric cleaning, on the other hand, shows no preference for size; it removes all sizes of particles to the extent of 85 to 90 percent of the total.

The War Department installation of Precipitrons will be the third in Federal Government buildings. More than two years ago, the Bureau of Standards installed a number of units in its chemistry building to prevent the contamination of chemical tests and experiments. Six months ago the Rocky Mountain Laboratory of the Public Health Service, in Hamilton, Montana, adopted this method of preventing dirt contamination of bacteria cultures in typhus fever research. Although this laboratory was in an isolated mountain district, one of the cleanest places in the country, tests showed that the air there contained about 200,000 foreign particles to the cubic foot.

The War Department Building will receive its 500,000 cubic feet of clean air per minute through 701 cleaning cells. Of these, 641 will be of standard size, each having a cross sectional area of three feet by eight inches; the others will be half standard size.

The Precipitron's action depends upon the electrification of the dirt particles. Each particle first passes a fine tungsten wire, where it takes on a positive charge. As it proceeds between a set of parallel plates, it is drawn out of the air stream to a pole of opposite polarity, where it sticks. Every few months a hose is used to flush the dirt from the plates and prepare them for another load.

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HALF MILLION TONS—Silver collected by the human race is estimated at 18,000,000,000 ounces. Of this, about one third is supposed to have been worn away, lost, or so well hidden that its whereabouts are unknown. Another third is supposed to be in the world's monetary stock, and the remainder hoarded or in family plate and other useful articles.

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GREASE FILMS

Fast Glassware Inspection in Restaurants

HEALTH officers, whose duty it is to make periodic checks on the cleanliness of glassware in public eating places, now have available a device which enables them to detect more accurately and speedily grease films and dirt which might otherwise pass undetected by the unaided eye.

It finds dirt

This new instrument, called the Rudd Grease-Film Viewer, is a combined light source and microscope. In use, as shown in one of our illustrations, a drinking glass is placed on a rotatable platform. The light bulb, supplied with current from flashlight batteries in the handle, is then turned on and the edge of the glass is viewed through the scope. By rotating the glass the entire rim can be inspected for finger prints, lipstick traces, and similar unsanitary deposits that have not been removed by proper washing.

CHEMISEAL

How Does a Seal Obtain Fresh Water?

THE seal, a meat-eating mammal which lives in salt water, obtains the fresh water necessary to the life of every animal by chemically manufacturing water in its body as a product of food digestion. A special mechanism in the kidney preserves this meager supply of fresh water by preventing the kidney from secreting it rapidly.

These facts were disclosed in a research report by Dr. Edwin P. Hiatt, of the Department of Physiology, New York University, and Dr. Stanley E. Bradley, of the Mount Desert Island Biological Laboratory, in Salisbury Cove, Maine. To study the process by which the water is conserved, Dr. Hiatt fed herring to a seal, studying the operation of the kidney after the feeding. It was discovered, he reported, that the kidney secreted water only when it was necessary for the elimination of wastes from the body.

SNAKESCENT

Rattlesnakes Detect Kingsnakes by Odor

RATTLESNAKES detect their deadly enemy, the kingsnake, by odor rather than by sight, it is strongly indicated by evidence presented by C. M. Bogert of the American Museum of Natural History. Kingsnakes, which average larger and stronger than rattlers, overcome and devour the latter whenever opportunity offers.

Mr. Bogert experimented with a considerable number of rattlesnakes of several different species, and also used one or two species of cannibalistic snakes other than the kingsnake. In general, however, the results obtained were the same for all species of both attacker and attacked.

Rattlesnakes, even those from regions where kingsnakes are unknown, always indicate recognition of their enemy by a peculiar defensive posture. The frightened rattler holds its head close to the ground, and throws a part of its body into a standing loop. With this it strikes against the kingsnake when the latter approaches, as a man might try to ward off an attacker with his elbow. To raise the head and defy the foe with bared fangs, as the rattlesnake does against any other enemy, would only expose it the more to a grab for the neck, which is the kingsnake's favorite hold. Another peculiarity of behavior is the rattlesnake's failure to sound its rattle when menaced by a kingsnake,

although this threatening buzz is also an invariable part of its behavior in the face of any other enemy.

Rattlesnakes dropped into empty glass vessels in which kingsnakes had previously been confined immediately went into this defensive attitude. They did the same thing when exposed to the odor of a kingsnake, scraped off its back with a freshly whittled, clean pine stick. They showed the defense reaction when they were first blindfolded with adhesive tape and then introduced into the presence of the enemy species. But when they were deprived of the ability to detect scent by removing their tongues (which are necessary parts of the smelling apparatus in snakes) they were indifferent to the presence of kingsnakes, although the latter were in plain view.—*Science Service.*

NOSES

Typical American Nose Not "Sam's" Type

Uncle Sam's "roman" nose is wrong.

The old gentleman traditionally is pictured with a decidedly convex nose whereas it should be rather straight, or only moderately convex, says Dr. Ales Hrdlicka, Curator of Physical Anthropology of the Smithsonian Institution.

Uncle Sam, as a symbolic figure representing the composite American man with a few generations of

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SHORT BUT SWEET—A rifle may serve a hunter or target shooter for a lifetime, but its active life is over in 30 seconds—each bullet passes through the barrel in such an extremely small fraction of a second.

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American and probably Anglo-Saxon ancestry, should comply with this composite, Dr. Hrdlicka says. Some years ago he made extensive measurements of the physical characters of a large group of old Americans of the more cultured and prosperous class. Recently he has made similar measurements on 150 of the foremost intellects in the United States.

In most respects, he points out, the symbolic figure is all right but he has almost never encountered in the two groups an "Uncle Sam nose." Among old Americans at large, 22 percent have straight noses and 42 percent have slightly or moderately convex ones. Among the great scholars the proportion is about the same.

"By 'nose shape,'" says Dr. Hrdlicka, "we understand the form of the dorsal ridge of the nose. This form is interestingly variable in man, and in the white races in particular. It is due in the main to the different developments of the bony and cartilaginous parts of the nose, but also to some extent to the soft parts of the organ.

"The shape of the nose changes more or less, particularly in males, from birth to old age. The shapes may be of a generalized racial character, they may be hereditary family peculiarities, or they may be individual differentiations for which no cause is discernible. In a group of prevalently elderly males the shape may be regarded as that of the fully matured plus some old-age modifications.

"There are four main types of nose. They are the concave, the straight, the aquiline or convex, and the wavy, or concave-convex. The concave as well as the convex may be moderate, medium, or pronounced."

The concave form, Dr. Hrdlicka

says, is the infantile. It tends to straighten out as the individual grows older, and as the fleshy parts of the nose increase in size. Sometimes this straightening is irregular, resulting in the concave-convex form.

SCREW DRIVER

Double Ended, for Phillips' or Slotted Heads

INCREASINGLY widespread use of Phillips' screws, which cannot be driven nor withdrawn by an ordinary screwdriver, has resulted in the design of the "Fitzem-All" screwdriver in which is incorpor-

Versatile screw driver

ated a double-ended blade. This blade is readily removable from a sleeve securely set into the handle of the screwdriver, so that either end of the blade may be used. One end is ground to fit Phillips' screw heads and the other for conventional slotted heads.

TUNG

Superior Trees Selected for Cultivation in South

SUPERIOR varieties of tung trees, source of the tung oil highly valued in the paint and varnish, linoleum, printer's ink, and other industries, are being given an extensive test by the United States Department of Agriculture. Because the Chinese war has drastically reduced imports from the principal source of this oil, while domestic plantings now in existence supply only a very small percentage of American requirements, new sources within United States boundaries are very seriously needed.

Department scientists caution that tung cultivation should not be undertaken by amateurs, and that it should not be attempted on a large scale even by experienced planters of other crops, reports *Science Service*. Tung trees are very "fussy" about their soil, highly sensitive to cold, and in any case must reach the age of five years before they come into bearing. Still, any farmer far enough south (within about 100 miles of the Gulf Coast) might find it profitable to set out a few trees, just as an experiment. Tung trees are quite ornamental, with glossy, heart-shaped leaves and beautiful flowers in spring.

Department of Agriculture plant scientists have, during the past three years, selected 500 trees in the extensive orchards already growing in the South as particularly promising. A second selection reduced the number to 80. Thousands of young trees were propagated from this group of parents. Last November's freeze cut down the nursery stock severely, but the survivors—some 40,000 of them—have been planted in 13 test orchards along the Gulf Coast, from Texas to Florida.

In the meantime, chemists in the Department have greatly improved the efficiency of oil extraction methods. American tung oil already commands a premium over the imported product, and the market is far from being saturated.

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NOT MUGGY—The amount of water vapor above the equatorial region of Mars has been found to be definitely less than 5 percent of that in the Earth's atmosphere.

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VITAMIN C

A Good Supply of it in the Good Old Spud

COOKED potatoes, whether new or old, add considerable vitamin C —ascorbic acid—to the diet regardless of whether they are baked, boiled, or steamed." So concludes Lydia A. Rolf, of the Bureau of Home Economics of the United States Department of Agriculture, after a scientific test to determine the effects both of cooking and of storage on the potato's ascorbic acid content.

The potatoes were cooked by methods commonly used by homemakers. In no instance did the potato lose more than 25 percent of its vitamin C value. In most cases the loss was even less, despite the fact that vitamin C is destroyed easily by exposure to heat and air. Boiling pared potatoes—probably the most common way of cooking —was the method most destructive of vitamin C.

This experiment, the Bureau points out, shows that a person can get a substantial part of his daily vitamin C requirement from potatoes. Army officials find that the potato supplies from one sixth to one fourth of the soldier's daily quota of vitamin C, and consider it a protective food because of this food value as well as its vitamin B_1 content.

Miss Rolf found that loss of vitamin C is great during the first few weeks of storage, greater than the loss during cooking. Comparatively, then, very new potatoes have more vitamin C value than do storage potatoes, although both were found to contain amounts sufficient to make a valuable contribution to diets.

MOTOR TORTURE

Humidity Tank Tests Electric Motors

THE superiority of a new transparent plastic insulation over older types of magnet wire insulation as used in electric motors is dramatically demonstrated by a testing method used at the Lynn, Massachusetts, River Works of General Electric. Test motors are placed in a metal tank, where they rest on steel rails above two inches of water. The tank is then sealed with

Temperature and humidity test electric motors

a heavy cover and electric immersion heaters in the water hold its temperature at the boiling point. Constant water level is maintained automatically. Thus the motors are operated in an atmosphere with a relative humidity of 100 percent, a condition which would probably never be met in ordinary service or which at worst could pertain for only a relatively short time.

RADIO RELAY

Extends Reliable Range of Portable Radios

A "RADIO-WAVE SPRINKLER," a new device which has proved successful in tests during the past year, was used to aid fire fighting crews on the National Forests last summer, the United States Department of Agriculture announced recently.

The sprinkler, developed by the Forest Service, will facilitate emergency communication in the forests. It is known technically as an automatic relay station in that it picks up radio waves from one point and transmits them to another, and is the first known development of an automatic relay of portable size operated by dry batteries. Searching parties and smoke chasers carry the small six-pound portable radio developed for parachute firefighters last spring, but such a radio is dependable only for a few miles although it may sometimes carry for distances up to a hundred miles or more.

In fire control work in mountainous country of the western National Forests, the automatic relay or wave sprinkler can be used to make communication with headquarters certain, the Forest Service says. When the small portable radios carried by forest officers on fire patrol can not send their waves over the mountain, they contact the sprinkler which automatically turns on its transmitter and rebroadcasts with a powerful wave to the base station. Attendants need visit the relay station only at infrequent intervals. It will enable the Forest Service to make dependable use of ultra-high frequencies and thus reduce need for use of other frequencies valuable for national defense purposes.

Searching parties hunting mountain climbers lost in the snow or snow sports enthusiasts who have gotten off trail, have often been unable to keep track of each other by present radio devices. By means of the radio sprinkler, one party

will be able to communicate with another directly under practically all conditions and thus may not only save time but human lives.

UNBREAKABLE

Transparent Container for Light Oils

A NEW method of packaging oil, known as Tri-Pak, is designed primarily for the sportsmen's kit, but also will find use for general household purposes and in machine shops. The oil "can" is said to be unbreakable, dentproof, and leakproof, yet is transparent. Thus the amount of oil remaining in the container can be seen at all times.

This new transparent container for oil has won awards in packaging competitions

INDIAN OIL

The List of Petroleum Derivatives Steadily Lengthens

IT wasn't many years ago that medicine-show men were touring the young United States, selling "Rock Oil" and "Indian Oil," to which they ascribed miraculous healing powers. Their stock in trade was crude petroleum, and in another way that same crude rock oil now is really living up to the advertising the "med-show" men gave it.

A bit of processing, unknown in the days of the medicine shows, is necessary, of course, and out of the processing comes a number of curative pharmaceuticals and such which relieve pain and contribute to cures.

Among them is novocaine, which makes dentists' chairs more comfortable; icthyol, a healing salve made from the crude oil obtained from certain shales; and formaldehyde, in itself an antiseptic, but when mixed with ammonia and other compounds, a drug with healing properties.

Glycol prevents radiators from freezing and helps in the manufacture of low-temperature dynamites. As glycol oleate it becomes an emulsifier which makes possible cosmetics, cold creams, brushless shaving creams, and lotions.

Of petroleum derivation are ethylene, propylene, and cyclopropane, mild anesthetics which can be used in cases where ether is inadvisable. From petroleum sources also come perfumes, astringents, theater sprays, shampoos, and even liquid rouge.

Typical is the production of glycerin from petroleum-refinery gases. Until recently glycerin was obtained only from animal and vegetable matter. Now it can be made from refinery gases by a process which chemists once said could not possibly work.

DIAMOND GRADING

New Instruments Make Standardization Possible

THREE instruments, invented by the Geomological Institute of America, are now making possible the first uniform method of grading diamonds for both color and imperfections. The first of these instruments, developed some time ago, is the Diamondscope, a specially constructed magnifying instrument for examining imperfections in the interior of diamonds and irregularities in cutting.

The other two instruments, just announced, are a mechanical color grader called the Colorimeter, developed by the Robert M. Shipleys, Sr. and Jr., and a uniform lighting unit, known as the Diamolite. With these instruments it is possible to establish an accurate standardization of those characteristics—freedom from flaws, excellence of cutting, and color—which, in addi-

Diamondscope

Colorimeter

tion to size, determine diamond values.

The Colorimeter accurately distinguishes the fine nuances of color in diamonds and compares them to a standard scale. Previous grading methods distinguished only seven color grades; the Colorimeter accurately distinguishes 13 colors within the same range. When the diamond is placed in a compartment in the Colorimeter, it is viewed through a low-powered microscope in comparison with a variable yellow scale. When the

Diamolite

color of this scale exactly matches that of the diamond, the grade of the gem is read on an indicator.

The Diamolite is used for comparing diamonds with the color of master stones. The light used in this unit is an incandescent lamp with a special blue filter which combination gives a spectrum which brings out the color nuances. The design of the instrument is such that it prevents reflection from the surfaces of the diamonds, making it possible to observe more accurately the true body color. Unlike natural daylight, the light in this instrument does not vary in quality or intensity from day to day or from hour to hour and hence gives an unvarying method of comparing diamond colors.

Industrial Growth

New Products and Processes That Reflect Applications of Research to Industrial Production

SANDER

Portable Unit With Reciprocating Head

A SMALL and compact unit for sanding operations, which holds a one-third standard sheet of abrasive paper on a resilient head surface, is said to duplicate the hand stroke of the master workman but at a rate which makes possible the finishing of four to five times as much work as could be accomplished by hand in the same length of time.

It gets into corners

This machine, the Nedco reciprocating sander, will reach into spots where hand sanding and other methods have been ineffective. The pad projects beyond the end of the mechanism housing so that the abrasive paper surface can be applied in otherwise inaccessable corners. The abrasive paper is held in place by a pair of sliding clips equipped with connecting springs, and can be quickly replaced. The unit is intended primarily to sand and rub fillers and paint coats on aircraft, motor car bodies, and so on. It operates effectively on either flat or curved surfaces.

VIBRATION

Traced by Direct-Reading Electronic Device

MAINTENANCE engineers have long realized that periodic vibration checks will prolong the useful life of machinery and equipment, save costly repairs and avoid shutdowns. Such checks, which make it possible to look for trouble before it becomes too serious, can be readily made with an electrical device called the Vibrometer, a simple appliance, made by Televiso Products, Inc., that is sufficiently rugged to withstand hard usage in the shop.

The indicator dial of the instrument operates through four ranges to indicate vibration from zero to one inch in amplitude. In operation the prod of the instrument is held in contact with equipment under test; amplitude of any existing vibration is shown directly on the instrument's dial. Smallest readable amplitude is .00001 of an inch; accuracy claimed is within 3 percent.

Shown in use is an instrument for routine shop checking of vibration, which, it is claimed, is affected only by vibration at the steel point—not by noises or other extraneous agitations

MARKING STAMPS

Coded to Identify Individual Inspectors

TO MEET conditions arising from triple-shift operation in defense industries, New Method Steel

Stamps, Inc., has designed and is producing a new type of inspectors' stamp. Instead of carrying a variety of designs to identify individual inspectors or operators, the new stamps are numbered from 1 to 99, the numbers in each group being enclosed in identifying shaped borders. Thus, one group has the numbers enclosed in a square, another in a triangle, another in a circle, another still—if needed—in an oval.

The device makes possible assigning identical numbers with different borders to inspectors or operators doing identical work. Thus inspectors can identify the operator making the part, as well as distinguish night from day shift operators or inspectors. Use of these stamps has a tendency to reduce inferior workmanship.

INSULATING BOARD

Light Weight, of Rubber, Easily Worked

Cellular rubber, a new material of high thermal insulation value that is twice as light as cork, is announced by United States Rubber Company. The name cellular is descriptive, since the material consists of a thin but dense external layer enclosing microscopic cells of nitrogen gas in a matrix of rubber. Each cell in the structure is distinct from its neighbor.

The insulation or "K" value (B.T.U. per hour per degree Fahrenheit temperature difference for a specimen one foot square and one inch thick) of cellular rubber, which will be marketed under the trade name of U. S. Royal Insulation Board, is expressed as .237. This is lower than any of the 37 types listed in the U. S. Department of Agriculture Handbook.

The figure compares with .30 for regranulated cork, .34 for gypsum in powdered form, .39 for laminated fibre board, and .59 for cellular gypsum dry.

Other specific properties claimed for the new rubber are: moisture resistance, rot proof, oil, acid and fire resistance, structural strength, long life, resistance to vermin and termites, and good workability.

Two weights of the insulation board are to be manufactured, only the lighter of which is to be fire resistant. The weights are: 4.5 pounds per cubic foot, and 5.5 per cubic foot for one-inch thick material. For lightness, this compares with 62.5 pounds per cubic foot for

water, and 70 pounds for pure gum rubber stock. Unusual structural strength is combined with this lightness. The 4.5 weight will withstand 22 pounds per square inch without crushing, and the 5.5 weight, 35 pounds.

The boards can be cut to shape with a bandsaw or powersaw, and can even be whittled with a knife. Surfacing can be done with a planer. The material is thermoplastic, and hence can be shaped by heating to 190 degrees or higher and bending while hot.

INFRA-RED HEATING

Inside-Silvered Lamps of New Type

ESPECIALLY developed for infrared processes in drying, baking, heating, and dehydrating, a new type of Nalco inside-silvered carbon filament lamp has recently been placed on the market by North American Electric Lamp Company. These lamps, the manufacturer claims, produce infra-red

For drying, heating, baking

radiation in the most desirable part of the Angstrom scale for maximum drying efficiency.

Readers interested in this particular type of work are also referred to the article "Infra-Red Does the Trick" which appeared on page 124, September 1941 issue, Scientific American.

INSPECTION

Telescope To Examine The Interior of Bores

WITH increasing attention being given to the finishing of machine surfaces, it becomes of greater importance to be able to inspect visually internal surfaces, such as the interior bores of rifles and so on. A new telescope for this purpose, known as the Type-A, product of the American Cystoscope Makers, Inc., permits examination of a one-

inch illuminated area of the interior of the bore with the image magnified four times. One of these units is shown in use in an accompanying illustration.

Objective lenses available for this telescope include one for viewing at right-angles to the telescope,

Interior bore examination

and others which permit direct, oblique, and retrospective observation. Sizes include telescopes small enough to enter a .2 of an inch bore. Illumination of the surface to be inspected is provided by a tiny lamp located in the extreme end of the telescope tube. The illuminated image is brought out to a lens at the outer end of the assembly where the eyepiece is provided with an indicating button to show the direction in which the objective lens is facing inside the bore. A rotating contact assembly is provided so that the telescope can be turned without tangling the extension cord.

GAS

Instrument Measures Fabric Permeability

THE "arsenal of democracy" is now being aided by a new instrument that will probably find many applications in industry, both currently and after the present emergency. This new instrument is the Fabric Permeameter—an accurate, rapid, and convenient means for production testing of the permeability of fabrics which are to be inflated with hydrogen, helium, carbon dioxide, and so on. The rate of permeation through the fabric is quickly determined by equipment utilizing the thermal conductivity method of gas analysis and is indicated in terms of "liters per square meter per 24 hours" of the retained gas.

The Fabric Permeameter determines the rate of gas diffusion through balloon fabrics and other materials and makes possible testing of the effectiveness of various "dopes" with which the fabrics are treated. The instrument was developed by the Cambridge Instru-

ment Company. The sample to be tested is clamped between two recessed test plates, thereby forming upper and lower compartments separated by the fabric being tested. Gas is passed into the lower compartment, while the upper compartment, which is filled with clean dry air, communicates with the metering unit. The gas which permeates through the fabric contaminates the air in the upper compartment and thus changes its thermal conductivity. A measure of the rate of this contamination provides a measure of the ability of the fabric to hold gas.

COLORED FLOORS

Concrete Surfaces Can Be Stained and Painted

COLORING and dust-proofing of concrete floors in all types of buildings is now possible with a new system which provides a surface coating that is alcohol and grease resistant and will retain its color even after being subjected to hard wear.

Materials for this processing of floors, made available by the Wilbur & Williams Company, are applied in two stages. First the concrete is dyed with a penetrating stain. Then the surface is coated with a synthetic enamel which adheres solidly to the stained concrete and which provides a dust-free surface. The enamel is put on in two coats. Even after the enamel coating wears down, as it will over a long period of time, the over-all color of the floor remains the same because of the dyed concrete beneath. The materials for this work are available in four colors.

BURR REMOVAL

Tumbling Equipment In Gun Manufacture

WHEN machine gun parts approach the finishing stages, it is frequently necessary to remove burrs before the gun can be assembled in completed form. Much of this work had been done by hand until the recent development of a new type of tumbling equipment by Hanson-VanWinkle-Munning Company.

The new tumbling units are driven by ½-horsepower motors through worm-gear speed reducers. The small machine parts from which burrs are to be removed are placed in the cast iron barrel of the tumbling unit together with silica sand and oil. Tumbling is then carried on for from two to four hours.

It is claimed that burr removal in this tumbling equipment results in a better finished product than does hand filing.

REFRACTORY

Insulating Brick For High Temperatures

BY EMPLOYING an organic filler together with a plastic refractory clay in the manufacture of a new insulating brick, the Johns-Manville Corporation is now producing a refractory which will withstand temperatures as high as 2600 degrees, Fahrenheit, in exposed service.

The use of the organic filler, which burns out when the brick is fired during manufacture, provides a finished brick with uniform pore structure.

RHEOSTATS

Multiple Range Units For Laboratory Use

CURRENT regulating devices for use in laboratories, either in the electro-technical, electro-chemical or educational fields, are now available in types which give a greater control range than heretofore possible. In the Rex Four-Range Rheostats recently placed on the market, one unit incorporates four different resistance values with corresponding current capacities, taking the place of four separate rheostats.

These control units are provided with two closely wound windings, so placed that each turn of one winding runs between two turns of the other. Both windings, controlled by one slider with lubricated contacts, are of wires of identical diameter but made of materials having different specific ohmic resistances. The resistance materials are insulated by Fiberglas, a material which retains satisfactory dielectric strength at the temperature reached when the rheostat is fully loaded. Because of the terminal facilities provided, four different operating resistances can be obtained by varying the connections to the unit. These rheostats are available in two different wattage capacities.

Keeping Pace

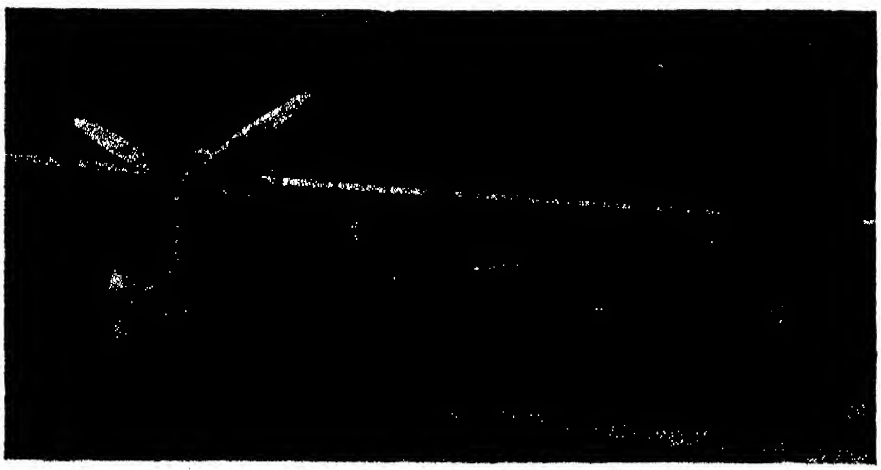
A Brief Glimpse of America's Largest Pursuit Plane Factory

ALEXANDER KLEMIN
Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University.

REPORTS of the progress of our plane production and of the extent to which we are sending aircraft to aid Great Britain at times are in conflict. Opinions vary from extreme pessimism to extreme optimism. Our own view is that in all probability there had to be a warming-up process, that plants had to be built and shops equipped before aircraft production on a really large scale could get under way.

In the meantime, announcements of new plants being put into operation are encouraging. At the Buffalo Municipal Airport, for example, the Curtiss-Wright Corporation has erected the largest American plant for the production of pursuit or fighter planes. The $18,000,000 plant with 1,500,000 square feet of floor space will turn out Curtiss Hawk P-40 Pursuits for the U.S. Army Air Corps, and Curtiss Kittyhawk fighters for the R.A.F. One of our photographs shows a Curtiss Hawk rolling off the production line.

Final assembly section for Curtiss Hawks and Kittyhawks



A Curtiss P-40 comes off the assembly line at Buffalo

America has been production-minded for a long time, but in the past excellent production has been achieved in indifferently constructed factories. Let us see what airplane engineers, working with Albert Kahn, the industrial architect, have been able to do in the modern factory. Disregarding statistics, the following indicates how rapidly industrial architecture is progressing under the impetus of war conditions:

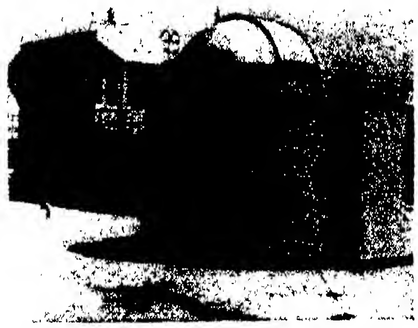
"To assure straight-line, unobstructed production throughout the plant, the cafeteria, locker rooms, and toilet facilities are located underground . . . production of all departments is equalized so that machine shop, press, sub-assemblies, and production departments keep pace with one another in moving a continuous stream of parts, sub-assemblies, and assemblies . . . three sets of doors, each 200 feet in width and each weighing 80 tons, located in the final assembly and flight hangar, may be opened or closed rapidly in units of 100 feet . . . forced ventilation system . . . all windows are equipped with complete blackout facilities . . . a 1000-foot tunnel extends the entire width of the basement and allows employees access from all departments to the parking lot."

MIRADOR

Part of Washington Airport Equipment

In our September issue we described the modern marvels of the Washington Airport, including the glass-walled control tower. A mirador shares the roof of the main building with this control tower. The dictionary defines a mirador as a "bay window, loggia or enclosed balcony, designed to command an extensive outlook" and the new airport mirador meets this definition perfectly. It is placed 75 feet above the level of the field and gives an excellent view of the rolling country surrounding the airport.

At either end of the graceful structure are revolving turrets which are used by observers to operate two theodolites. These are merely telescopes mounted on tripods, through which the observer watches the ascent of a small balloon. The balloon has such buoyancy and weight that it ascends at a constant rate. Knowing the rate of ascent and taking readings on the scales at the base of the theodolite, the observer can tell the velocity and direction of the wind at various altitudes above the field. Thus it is possible to tell the pilot that he will have favorable winds at one altitude, quartering winds at another altitude, and so on. Theodolites can follow the balloons, which are three feet in diameter, to a height of seven or eight miles, and to a distance of 20 to 25 miles on clear days.—*A. K.*



Mirador and theodolite turret

BLOCK SIGNALS

Bring Aid to Airline Dispatchers

Flight dispatchers on the airways are important men who control all the planes in a given area and must therefore at all times be informed of the position of such aircraft, whether aloft or at the airports. At present the dispatchers depend upon radio messages from pilots. In a new system, recently developed by Transcontinental & Western Air, the radio messages will still be necessary, but the dispatcher will have the help of an "automatic block signal" system which will make his work much easier and more effective.

As one of our photographs shows, the device consists of a panel fitted with a series of tracks, each representing a directional airway. Each track works on a long, electrically driven worm, which turns at the rate of two revolutions per minute, though the exact speed may be regulated to correspond with the ground speed of the airplane on the airway. A small brass block, representing the airplane, travels up or down the track, at the speed allowed for in the pilot's flight plan. Check points on the airway are represented on the dispatch board by slots set at correct scale intervals. As the plane approaches a slot or block and the dispatcher receives a radio message, he closes the block, allowing the symbolic airplane to

pass on to the next checking point.

If the miniature plane reaches the block without appropriate message from the pilot, it drops into the slot and rings an alarm. Thus the Flight Superintendent is notified of the delay and an inquiry is started.

The invention will enable the Flight Superintendent to keep a positive double check on the plane's position — from the dispatch board and corroborative advice from the pilot. The airway panels work in conjunction with a master control or dispatch board. The devices are to be set up very shortly in New York, Chicago, Los Angeles, and San Francisco. — *A. K.*

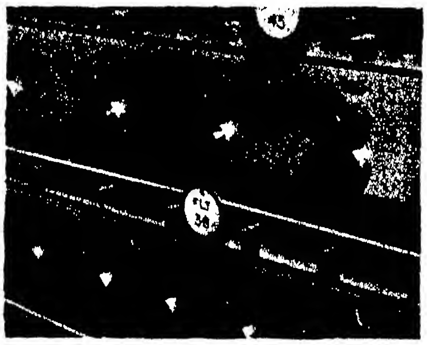
FLOATS

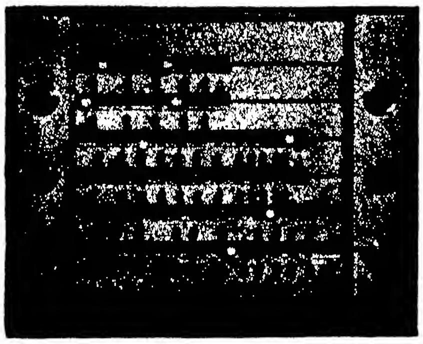
Plywood Construction Found Satisfactory

The aluminum shortage is particularly dangerous for aircraft production, so every effort to substitute plywood for aluminum is helpful. Now we hear of plywood floats, designed by C. K. Wollam, of National Plywood, for use on the Piper Aircraft Cub. Plywood was used for float and hull construction early in American aviation but deplorable service experiences in water absorption and tearing away of the plywood earned it a very bad name.

However, Mr. Wollam's present designs seem quite successful. The fundamental reason for the poor showing of earlier types was that in the old plywood no glue then available was completely water resistant or perfectly immune to bacteriological attack. The modern plywood glues, such as the plastic phenol resin type, are perfectly water resistant and immune to bacteria, since they are inorganic in origin.

Float construction is of the advanced semi-monocoque type, with internal bracing, and water-tight compartments provided with bulkheads. Costs are said to be low, and Bakelite varnish finish to be effective. Five-ply birch is used for the float bottoms.





Above: **Close-up of "automatic block signal" board.** *Left:* **A detail of the board with numbered block on worm.** *Below:* **The master control dispatch board which is supplemented by block signals**

CAMERA ANGLES

Conducted by JACOB DESCHIN, A.R.P.S.

Coat Your Own Blackout Bulbs

A SIMPLE method by which any amateur may turn out infra-red bulbs by dipping ordinary flashbulbs in a "blackout" formula, was described by Kenneth Murray, of Colon, Michigan, in "Photography Handbook." Mr. Murray offers the following formula for the infra-red varnish:

Eosine, Color Index 768 ..	4 grams
Tartrazine, C. I. 640	6 grams
Acid Violet, C. I. 698	4 grams
Napthaline Green V, C. I. 735	10 grams
Gelatin (Nelson's Hard)	200 grams
Glycerine	100 c.c.
Water, to	1000 c.c.

In attempting to assemble the necessary materials preparatory to a test of the method, we found that all the items were available from Fezandie and Sperrle, of New York City. Because of war conditions, however, a substitution had to be made in the case of the gelatin, the Nelson's Hard Gelatin not having been available for some time. Therefore, a domestic make was used, that of Haslett and Vivorde, called Photogelatin. A half pound is all you need.

Mr. Murray's directions follow:

"Soak the gelatin for an hour in one-half the fluid volume of water, then warm to 100 degrees, Fahrenheit, until it dissolves. Each of the dyes must be dissolved separately in a small quantity of water—the Acid Violet being added a little at a time—dissolving each addition before adding more. The water may be warmed, but to not more than 125 degrees, Fahrenheit. Dilute each solution with a little of the gelatin solution and dilute the glycerine with an equal quantity of warm water. Mix the ingredients, prepared as above, one at a time, and add the remainder of the water. Any air bubbles should be removed by a clean muslin filter.

Figure 1: With and without

"Keep the dyed gelatin solution at 96 degrees, Fahrenheit, and immerse the bulbs one at a time. As each bulb is slowly withdrawn, turn it cap downward for a few seconds, then invert it, in order to secure an even coating. Allow the bulbs to dry for at least 24 hours before returning to the original containers for storage."

We poured the gelatin into a small tray containing the specified amount of water and placed this tray in a larger one. After an hour or so, when the gelatin had soaked up the water and therefore had swelled up, we allowed hot water from a faucet to run into the larger tray until the gelatin was dissolved. In the meantime, we mixed the dyes, one at a time, in one to two ounces of water, then mixed a little of the dissolved gelatin in each, and poured the solutions successively into a one-liter graduate. Then we poured in the rest of the dissolved gelatin and finally the diluted glycerine. Air bubbles appeared, so we filtered the solution through clean muslin. Filtering requires considerable patience as it is rather slow work; the solution jells rather quickly as the temperature

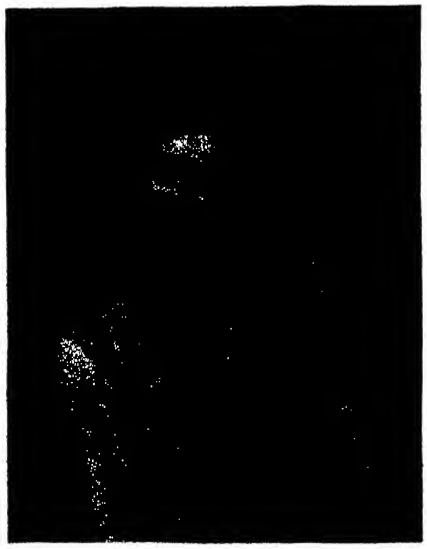


Figure 2

drops (which naturally occurs as the dyed gelatin is poured from the graduate, which was kept standing in a tray of hot water) and it was necessary to filter only a little at a time.

The filtered gelatin solution, hot-water jacketed in a tray to maintain the temperature as near as possible to 96 degrees, Fahrenheit, was now ready for the dipping. Two types of flashbulbs were used, Superflash No. 2 and General Electric No. 50, in order to obtain light sources of different intensities. To protect the fingers, we wore rubber gloves. Since the bulbs would naturally have to be dryed by

suspension individually, we cut up some thin wire into short pieces and wound one end around the threaded neck of the bulb and twisted the other end into a loop for hanging.

The bulbs were then dipped individually in the filtered solution and drawn out very slowly with a revolving motion. When completely out, the bulb was turned cap downward, held thus for a few seconds, then inverted again. This was done several times to assure an even coating. Exposed to the cool air, this gave an opportunity for the varnish to jell and prevented dripping when suspended. The operation completed, the bulb was hung on a hook to dry. During the processing, the fingers may become stained by

Figure 3

the dyes, but may easily be washed clean with ordinary soap and water. Should you run short of bulbs for ordinary flash purposes, the entire jacket may be removed simply by placing the bulb in warm water.

By test, we found that the dye-coated Superflash No. 2 givês a proper exposure at $f/8$, 1/50 of a second, with the lamp six feet from the subject, and the General Electric No. 50 (which must be exposed by the open flash method), at the same distance, about $f/11$ or a little larger.

Properly treated, the bulbs give off only a dull red glow. However, there is a tendency for the solution to leave a narrow untreated strip at the extreme end of the neck of the bulb. Also, because air bubbles are inclined to persist, particularly at the ball end of the bulb, particular care must be taken to avoid this. In spite of every precaution, however, the two faults mentioned will persist, with the result that a faint white flash may be seen. Although this does not appear to hinder the characteristic infra-red results, it is obviously to be avoided. We found that the faults could be mended by covering the small areas thus exposed with black masking tape.

Some interesting variations are possible with infra-red that were not treated in our article on the subject

"Horror" by infra-red

in the October number. One is the "horror" picture, a type of photographic slapstick made more startling by "blackout" bulbs. Another is illustrated in Figures 2 and 3, which show the effect of "blackout" make-up. This make-up consists of the application of X6 Shadow tint (dark brown) and the brown eyebrow pencil from the Hampden Panchromatic Make-up Kit. By applying the pencil to the lips, the lips appear relatively as they

Drying the bulbs

do in ordinary photography. Also, flesh tones appear much more natural and exhibit beautiful gradation. Figure 1 is a comparison shot illustrating the effect of infra-red on a normally made-up face and one treated with the special make-up for infra-red.

Marines

MAYBE this is something that needs clarification, and maybe what's the difference. Anyway, what do you think? In a photographic contest sponsored by the Long Island Association, some question has arisen among contestants as to just what the committee meant by dividing the

OVER $1100 IN PRIZES
36 CHANCES TO WIN

Sixth Annual
SCIENTIFIC AMERICAN
AMATEUR PHOTOGRAPHY CONTEST

POPULARITY of the divisional method of judging photographs in the Scientific American Annual Contests, as determined by the enthusiastic response in past years, has been so great that the method is once more being used for the Sixth Annual Contest. In each of the divisions listed below there will be awarded seven major prizes and five honorable mention awards, a total of 36 prizes in all.

Please read the rules carefully and abide by them. Note particularly Rule 6, under which any contestant may enter a total of six prints, but no more than two in any single division.

Divisions In Which Prints May Be Entered

Division 1. Human interest, including camera studies of people, animals and so on. Portraits will be grouped in this division.

Division 2. Landscapes, including all scenic views, sea scapes, and so on.

Division 3. Action, including all types of photographs in which action is the predominating feature.

THE PRIZES

1st. Three $125 LONGINES, Coronation Model, Solid Gold, Men's Wrist Watches.

2nd. Three $90 LONGINES, Presentation Model, Solid Gold, Men's Wrist Watches.

3rd. Three Intercontinental Marketing Corporation PHOTRIX "22" Enlargers, complete, less lens. (List price $54.)

4th. Three Burleigh Brooks FOTH-DERBY Cameras, with built-in coupled range finders. (List price $34.75.)

5th. Three WESTON No. 715 Exposure Meters. (List price $24.)

6th. Three ABBEY Vimo Flash Guns. (List price $13.75.)

7th. Three Raygram LEE Timers. (List price $12.50.)

Five Honorable Mention Awards, each to be a new or renewal subscription to Scientific American for one year.

Address all Entries to

Photograph Contest Editor, Scientific American

24 West 40th Street New York, N. Y.

Rules of the Contest

1. The groups will be judged independently on the basis of pictorial appeal and technical excellence. The decision of the judges will be final. In case of a tie for any prize, duplicate prizes will be awarded to the tying contestants.

2. Prints must not be smaller than 5 by 7 or larger than 11 by 14 inches. *All prints must be mounted*, otherwise they will be returned immediately.

3. Photographs must be packed properly to protect them during transportation.

4. Non-winning entries will be returned only if sufficient postage is included when the prints are submitted.

5. Each entry *must* have the following data written on the back of the mount: Name and address of contestant, type of camera, and film, enlarger, and paper used.

6. Contestants may submit no more than two prints in each group, but may enter any or all groups. In no case, however, will more than one award be given to any individual contestant.

7. Prints must be in black and white or monotone. Color photographs are not eligible.

8. Prize-winning photographs will become the property of Scientific American, to be used in any manner at the discretion of the publisher.

9. Scientific American reserves the right to purchase, at regular rates, any non-winning entry.

10. No entries will be considered from professional photographers.

11. All entries in this contest must be in the hands of the judges by December 1, 1941. Results will be announced in our issue dated February, 1942.

12. The contest is open to all residents of the Western Hemisphere who are not in the employ of Scientific American.

13. In fairness to all contestants, failure to comply with any of the above rules will result in automatic disqualification.

THE JUDGES:

McClelland Barclay
Artist

Ivan Dmitri
Artist and photographer

T. J. Maloney
Editor of U. S. Camera

Robert Yarnall Richie
Photographer

classification of marine subjects into two parts. So William H. Kniffin, vice-chairman of the committee, explained as follows:

"The contest committee felt that it was necessary to divide the marine classification of subjects into two parts in order to emphasize the desire to secure photographs of scenes along the shore lines and waterfronts. Many people, including a large majority of amateur photographers, always have considered 'marines' as pictures taken only on the water, such as boats, fishing, sailing, flying waterfowl, swimmers, and so on, without including shore lines or waterfronts.

"We especially want photographs of sand dunes and beaches; nature studies of sea and land life along the beach; sand and wave patterns; docks, wharves, jetties, boat moorings and landings. Such subjects are equally in demand with pictures of objects entirely on or in the water."

In view of this explanation, was the committee justified in dividing the marine classification?

Eliminating Variables

MANY workers, particularly beginners, are sometimes bothered and confused by the several variables involved in the exposure routine. Among others, these include the speed of the film emulsion, the *f*/ stop, the shutter speed, focusing, and so on. By eliminating as many variables as possible, photography is simplified and more attention may be given to the prospective pictures themselves.

Suppose we start with the shutter speed. For miniature type cameras, we would recommend a standard shutter speed of 1/100 of a second or 1/50 of a second, to minimize camera shake as much as possible—a point of particular importance with miniature negatives that have to be enlarged to 8 by 10, 11 by 14 inches, and larger. If your shutter speed is always set at 1/100, you can forget that variable entirely, altering only the *f*/ stop.

If you are shooting a number of pictures outdoors with about the same light distribution, you can set your diaphragm at say *f*/8 or *f*/11, or smaller, depending on the speed of the film, and forget that too. By using one film you also eliminate the film speed variable. As for focusing, by using a small stop you can follow box-camera technique and limit all your shooting to objects beyond a fixed distance from the camera.

Color at 5:30 A.M.

A HEAVY fog at the waterfront spelled the possibility of shooting color into the sun after the fog had thinned out a little and allowed the mellow light to come through and cast its warm reflection on the water. This was the prospect as we awoke one foggy morning on a July vacation in Provincetown at the tip of Cape Cod. Fortunately, this was not only the prospect but the actuality as we reached the wharf. The sunlight came through and cast a mellow, golden light on the quiet surface of the bay. Guided by the exposure meter, we exposed Kodachrome at *f*/9, 1/30 of a second. The result was a beautiful record of a scene that reproduced with marvelous fidelity to the original. A black-and-white shot made at the same time did not begin to tell the story or recall the scene that the color shot revealed in all its glory.

From A Ferris Wheel

IF YOU don't take a chance, you'll never find out. So we did. We happened to be in the cage next to the one carrying our companions. At leisure, knowing we would meet

1/200 at *f*/4

again and again as the wheel revolved, we measured the distance by range finder. It happened to be 10 feet. Setting the shutter at 1/200, stop *f*/4, we bided our moment to make the shot in the couple of seconds when the carriages were suitably juxtaposed. Then we edged the lens inside of one of the apertures in the wire screen to give it a free view of the subject, and made the first shot. This was a failure. The second is shown in the reproduction.

Hypo Eliminator

CONSIDERABLE interest has been created recently in Eastman's Hypo Eliminator formula, HE-1, designed to give prints maximum permanency. It is recognized that, due to the fact that the sulfur in the residual hypo ultimately combines with the silver of the image to form yellowish brown silver sulfide stains ("fading"), the complete elimination of hypo from papers is difficult, if not impossible. The Hypo Eliminator

formula, which follows, gives the greatest possible insurance against eventual fading:

Kodak HE-1

Water	16 ounces
Hydrogen Peroxide (3% solution)	4 fl. ozs.
Kodak Ammonia (3% solution)	3¼ fl. ozs.
Add water to make	32 ounces

Wash the prints for about 30 minutes at 65 to 70 degrees, Fahrenheit, in running water which flows rapidly enough to replace the water in the vessel completely once every five minutes. Then immerse each print for about six minutes at 70 degrees in HE-1 solution and finally wash about 10 minutes before drying. At lower temperatures, increase the washing time. For doubleweight prints, washing time should be doubled.

Pipe Cleaner for Local Work

For the worker in a hurry a handy little tool for local reduction or intensification is the lowly pipe cleaner. Just bend the end a little bit, making sure the sharp wire tip end is bent up, dunk it into the solution, and you are ready to reduce that small dense area or intensify the thin one. For larger areas, the wire can be bent several times, lining the bends alongside each other. The rest of the pipe cleaner makes a reasonably stiff handle for the purpose.

Weighing Large Quantities

With the small pans in use on amateur photographic scales, it is sometimes difficult to avoid spilling chemicals when weighing such relatively large quantities as two or three ounces of such a chemical as carbonate, for example. The usual result is that, as the chemical is poured into the pan, a pyramidal mound is formed which eventually causes a spillover from the sides unless the worker is extremely careful. Here is a stunt that should be helpful in this connection. After pouring part of the total quantity into the pan, dig a "crater" in the cone with your finger. Then pour some more and dig again until the total quantity has been poured. By the "crater" system, the portion already in the pan is not disturbed and the newly poured portion is easily contained within the cavity.

Cleaning Tanks

The Nikor tanks we use in our darkroom get a pretty thorough workout over the course of months, so it is natural that their interiors, originally as bright and shiny as their exteriors, eventually become dulled. Also, it occasionally happens that, in manufacture, due to the difficulty of drawing the tanks, which are made of very tough stainless steel, the tools used to shape them get caught and in the effort to pull them loose some metallic deposit is left, mixed in with the stainless steel. This eventually causes so-called "rust" spots to appear. These spots are effectively eliminated, we have found, and the general appearance of the tank walls improved, by rinsing the tank with a 10 percent solution of nitric acid— one ounce of nitric acid in ten ounces of water. Fill the tank to the brim and allow to stand overnight. Following this bath, the tank is thoroughly rinsed in plain water and then wiped dry and bright by using paper toweling or a soft cloth.

Lecture-Demonstrations

When this issue of Scientific American reaches the reader, there will still be time for those in the vicinity of New York City to attend the last half of the series of six lectures on photography evenings being given on Thursday evenings at the 336 Madison Avenue store of Abe Cohen's Exchange. The lectures begin promptly at 8:00 and are planned for the beginner in photography with the hope of helping him to make better pictures with available equipment. The following lectures are still to come: October 23rd—Getting the Most Out of Color Film, by E. G. Bancker of Eastman Kodak Company. October 30th—Portraiture with your Equipment, by Carlyle Trevelyan. November 6th—Films, Filters and Exposure, by Henry M. Lester.

• • •

WHAT'S NEW

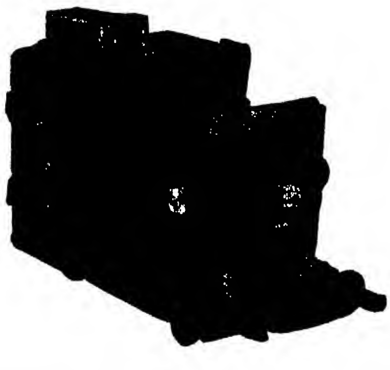
In Photographic Equipment

New Kodak Bantam Special Camera: Now equipped with Kodak Ektar *f*/2, 45mm lens and Eastman's Supermatic shutter. Lens treated with surface coatings 1/50,000 of an inch thick on inner glass-air surfaces of lens elements, improving clarity

and image brilliance. Better contrast with black-and-white and greater color purity with Kodachrome. Improvement achieved by materially reducing reflection from glass-air surfaces within lens. Speed-selecting ring on Supermatic shutter engraved in red for "Time," "Bulb," 1 second, ½, 1/5, and 1/10 (speeds requiring camera to be mounted on tripod or

other firm support; (engraved in black for 1/25, 1/50, 1/100, 1/200, 1/400, for hand-held exposures). Split-field range finder lens-coupled. Range finder eyepiece adjustable for individual eyesight. At left of index mark on engraved distance scale is red index mark for manual focusing compensation when using infra-red film. Accessory: tan leather field case.

WATSON 2¼ BY 3¼ MINIATURE PRESS CAMERA: Designed to take all standard press camera accessories. Telescopic eye level view finder ad-



justable for parallax. Ground glass focusing panel fitted with folding hood. Double extension bellows travels on all-metal V-grooved track. Removable lensboard.

KODAK CHRISTMAS GREETING CARD OUTFITS: No. 6 contains eight negative masks; two vertical, two horizontal for 2¼ by 4¼-inch negatives; two vertical, two horizontal for 2¼ by 3¼ negatives. Each mask includes holiday sentiment, opening for negative, guide for placing paper. Also supplied: embossing guide for 4¼ by 5½-inch cards; metal foil gummed seals, instructions. No. 7 outfit includes two masks, one horizontal, one vertical for 2¼ by 3¼ negatives; six negatives of greeting sentiments, embossing guide for 4¼ by 5½-inch cards, instructions.

LEITZ SLIDE CLEANER: For cleaning cover glass plates. Available in two-ounce bottles with special applicator; latter is pliable, plastic "test tube" having stopper made of sponge rubber, which, moistened with solution, is used to clean glass. Glass is then rubbed dry with clean cloth. Cleaner will remove dirt, grease, smudges, fingerprints. Can also be used to clean outer surfaces of bound slides or for cleaning lenses, condensers, and so on.

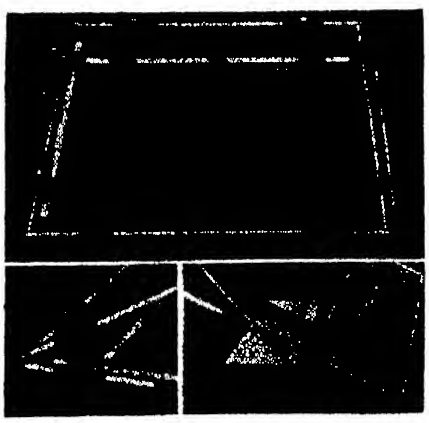
KALART AUTOMATIC SPEED FLASH ($10 for synchronizing unit alone; $14.95 with Compak battery-case-reflector combination; $18.50 with Kalart Master Battery case and reflector): Mechanical type; fully automatic, requiring no winding or cocking before use. Also is universal, fitting practically any type camera having cable release socket. Can be used with miniature focal plane cameras by addition of simple adapter. Measures only 1½ inches long, ½ inch wide. Synchronizer unit itself snaps into jack terminals of battery case; requires no cable release, eliminates all wires. Armored, flexible coupling connects synchronizer to shutter. Coupling adjustable for variations in shutters.

BOLEX FRAME COUNTER ($17.50, special winding handle, $5): Attaches to motor crank shaft of camera and counts individual frames while camera is in forward or reverse motion, whether being run on spring motor, electric motor, or by hand.

NEW BELL & HOWELL BUILT-IN EXPOSURE CALCULATOR: Compensates for film emulsion speed, filter factor, and camera operating speed, in addition to external factors governing exposure: brilliance of light, type of scene, season, time of day. Gives direct readings for Kodachrome at normal speed with single turn of dial.

F-R ENLARGER ($42.50 without lens; tripod model $54): Takes negatives up to and including 2¼ by 3¼ inches. Two models: standard bench or table (No. 5); tripod model (No. 6). Features: Double condenser system, using oversize condensers; negative carriers of revolving, glassless type. Each enlarger supplied with 2¼ by 3¼ negative carrier; other sizes optional. Other negative carrier sizes down to 35mm; lens board carrier takes either metal or wood lens board; distortion control features.

NIKOR ENLARGING EASEL ($7.50): Constant center type easel provided with thin steel base, permitting maximum enlargement and use on autofocus type enlargers. Finished in



"safelight red." Parallel, uniform borders, from ⅛ of an inch up, on paper from 2¼ by 2¼ to 11 by 14 inches, assured by long, accurately machined bearings and unique guide for masking band frame, which stays up or down without catches. Friction material prevents slipping in normal use. Provision made for anchoring in fixed position, if desired.

Conducted by A. D. RATHBONE, IV

INTEREST IN FIREARMS *is traditional with American men; fishing tackle is a requisite of one of the world's oldest occupations. Scientific development of guns and tackle, in the use of which millions yearly find sport and recreation, fathers this monthly department which welcomes correspondence from readers.*

The Johnson Semi-Automatic Rifle

FOR FOUR years after this gun was invented—in 1936, by Captain Melvin M. Johnson, U. S. Marine Corps Reserve—intensive development and engineering studies were made with test models to ascertain high and low operating tolerances and to determine whether rifle would operate satisfactorily with interchanged parts. Therefore, when the gun was put into production early this year by Johnson Automatics, Inc., and its subsidiary, The Johnson Automatics Manufacturing Company, it was not particularly surprising that, in view of the records established by this shoulder weapon during its test period, deliveries were started shortly thereafter to a friendly foreign nation. Providing added fire power for the average soldier, the gun will take the place of the regular bolt-action infantry rifle now used by that nation's armed forces.

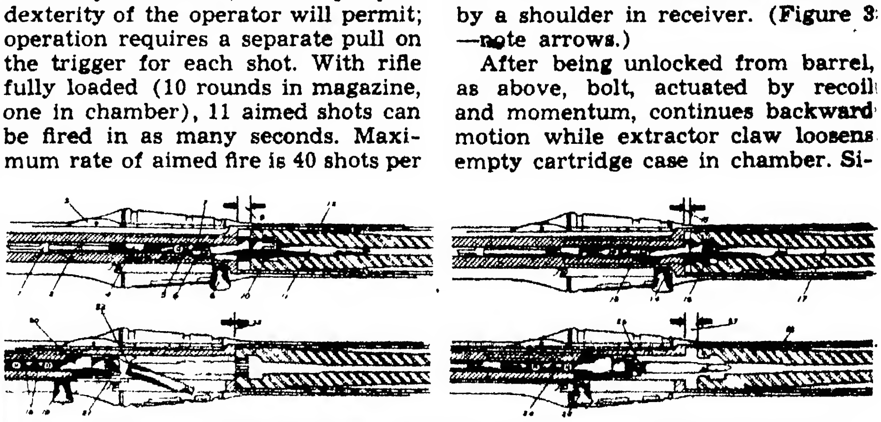
The Johnson Semi-Automatic is a .30-'06 caliber rifle of the short recoil type, equipped with a 10-shot capacity rotary type feed magazine loaded from standard Springfield type clips or with single cartridges. Utilizing the recoil force to operate the mechanism, the gun has a theoretical cyclic rate of fire of 600 rounds per minute, but may be fired as slowly as desired, or as rapidly as dexterity of the operator will permit; operation requires a separate pull on the trigger for each shot. With rifle fully loaded (10 rounds in magazine, one in chamber), 11 aimed shots can be fired in as many seconds. Maximum rate of aimed fire is 40 shots per minute; normal rate of aimed fire is 15 to 30 shots per minute, depending on range, size and visibility of target, and so on.

Exhaustive tests, it is claimed, showed that under sustained rapid-fire conditions accuracy of aim is not seriously impaired by the automatic action. The recoil is partially absorbed in operating the mechanism, and the "kick" against the shoulder is thus substantially reduced. This recoil force is harnessed to motivate action of the gun, which will fire only if breech is closed and locked as in Figure 1—note small arrows.

After ignition, and as bullet travels through bore, the barrel, which has been held in forward position by tension of both recoil and main springs (transmitted through the bolt), begins to recoil *with* the bolt against tension of the springs, as in Figure 2. (Note space between arrows.)

By the time bullet has reached muzzle, barrel and bolt have moved rearward about 1/64 of an inch; when bullet is about two feet out of muzzle, this retraction totals approximately 1/8 of an inch. Camming arm on bolt now engages camming face in receiver and unlocking begins. With bullet some five feet from muzzle, barrel has reached maximum recoil position—3/8 of an inch—bolt has been rotated through 20° to unlocked position by action of camming arm against camming face, and rearward movement of barrel is arrested by a shoulder in receiver. (Figure 3—note arrows.)

After being unlocked from barrel, as above, bolt, actuated by recoil and momentum, continues backward motion while extractor claw loosens empty cartridge case in chamber. Si-



Top, left to right: Figures 1 and 2. Lower, left to right: Figures 3 and 4

multaneously the locking cam, motivated by impetus received during rotation of bolt, delivers sharp blow to bolt, forcing it back in its channel, thereby drawing cartridge case from chamber, cocking hammer, and compressing mainspring. (There is sufficient residual pressure in chamber to assist extraction appreciably by blowing loosened case from chamber — Figure 3.) Coming in contact with ejector, empty case is thrown clear of receiver, rearward action of bolt is arrested by bolt stop, and face of bolt has passed back of base of top cartridge in magazine.

Counter recoil now begins, actuated by compressed mainspring. Bolt moves forward, contacts base of top cartridge in magazine, which is forced up by spring pressure of magazine follower, and drives it toward chamber. Meanwhile barrel has returned to firing position (Figure 4, note arrows), locking lugs enter barrel locking bushing, and locking cam causes bolt to rotate through 20° to locked position. The hammer, cocked as above described, is held in cocked position as bolt group moves forward and must be released by trigger before another shot can be fired. When maximum speed of aimed fire of the rifle is attained, this cycle of action is repeated 11 times in 11 seconds.

The complete and far more detailed story of the Johnson Semi-Automatic rifle is presented, together with 31 excellent illustrations and charts, in the 70-page "1941 Instruction Manual of the Johnson Semi-Automatic Rifle." Herein we could give only an all-too-brief picture of this interesting firearm and a digested version of the fire cycle. The "Manual," by Charles T. Haven, co-author of "A History of the Colt Revolver," contains a list of parts and their detailed descriptions, chapters on Operation, Functioning, Disassembling and Assembling, Care and Cleaning, Accessories, and other data. Mr. Haven has also compiled a chart 25 by 38 inches, showing the Johnson Semi-Automatic in halftone to ¾ scale, with section drawings of parts in normal position, the fire cycle, and a stripped halftone view of the rifle disassembled. These items are now available to anyone interested.

Latest Stoeger Catalog

It's always a pleasure to announce to the firearms fraternity the imminence of a new edition of Stoeger Arms Corporation's catalog. Long known as "The Shooter's Bible," this 1942 publication is more comprehensive than ever, for in addition to shotguns, rifles, and handguns of all descriptions, it depicts a complete line of articles for the outdoorsman, including camp equipment, clothing, boats, outboard motors, and so on; also, equipment for skiing, tennis, badminton, and other sports. The gun section excels, as usual, and contains latest current prices. In our opinion, you can't get along without "The Shooter's Bible"—it's a reference book, an authoritative source of information, and an excellent buyer's guide.

Camouflage Cape

Now comes the science of artistic camouflage to aid duck and crow shooters. Many a nimrod has supposed himself well hidden in his blind, only to discover, when the flight came down, that the wary, sharp-eyed birds had spotted some incompletely covered part of anatomy or equipment, and had veered off before flying into range. With the "Camouflage Cape" and complete immobility, the hunter can simulate to perfection a large tuft of swamp grass, an abandoned corn shock, a sheaf of wheat. When birds come in to the decoys, he rises to crouching or standing position, the cape—weighing but 1¾ pounds—opens and slips back off the arms, permitting unrestricted action. Made of light, durable, olive drab canvas with strips of elastic stitched at intervals to form loops for camouflage, the "Cape" has an adjustable elastic throat strap with black snap fasteners. It is water repellent, is worn over regular hunting clothing. Want a descriptive folder?

To fool the ducks, you emulate a strawstack

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced."

PAPOOSE is what Verl J. Douglas, Santa Paula, California, calls the rather large (as finders go) reflecting finder on his 10" reflecting telescope (Figure 1). He scarcely mentions the main telescope which, however, is itself a sturdy instrument sturdily mounted, but is intrigued by his discovery that he could make a 22×, 1½° finder that would itself split Theta Orionis and show its nebula, also show the rings of Saturn and pick out Uranus and Neptune from the surrounding stars more easily than a binocular, from nothing but a ten-cent-store caster cup for the mirror disk and a ⅝" prism from an old binocular. He says it out-performs, as a finder, a refractor as usually used for a finder costing much more than it did—meaning it has the powers of a 3" aperture, which the smaller apertures usually used on finders do not.

Figure 1: **Telescope, papoose**

PERFORATED sheet iron makes an attractive telescope tube, and one which is well ventilated and thus not subject to the pocketed air current effects that sometimes are troublesome where the tube is solid and the mirror closed in—effects that often cause a deterioration in seeing. Rev. J. F. Peat, Bellville, Ohio, a retired China missionary, who used to do star gazing in China, used this material, bought at an ordinary hardware store, in the 6" reflector shown in Figure 2.

His mounting, a double yoke type with pipe-fitting declination axes, has elements of originality and he says the telescope gives complete satisfaction—"I really have a grand little telescope." It has a celluloid protractor declination circle.

THIS magazine's stock of copies of the book "Amateur Telescope Making" having become once more exhausted, a new printing was made and the opportunity was used to make a few minor corrections and to revise entirely the last 36 pages of the book. Yet we don't think this is enough of a change to justify calling this a fifth *edition*—maybe you'd feel a bit cheated—so it is still the fourth edition. Fourth edition, third *printing*, to be precise.

The old book reviews on pages 469-476 needed revision, likewise the Directory, and, especially, the list of astronomical and telescope making clubs. Wates, of Canada, also didn't like the index; nor did various others, including your scribe, who originally made it. So practically the whole back-yard part of the book was chucked out and a new one made.

Much more space than before has been given to the book reviews, both for their number and detail. Practically all the important astronomical and telescoptical books in the English language are now not merely listed in "A.T.M." but described in some detail. The new printing reviews 76 books (and it was a real job to do the reviewing). Not all are new books—mere newness isn't, in this field, the universal criterion of usefulness—but mainly the books have been published within the last few years. Nearly a page, for example, is given to telling just what's in Conrady's famous "Applied Optics and Optical Design." Few can afford this expensive work, not very many can even understand its mathematics, but nearly all would like to know approximately what it's like. Or just what's in the Ephemeris.

There is also a new list of astronomical journals, a new list of astronomical societies, a list of 70 local groups of amateur astronomers and telescope makers. To compile this and obtain the correct names, also local adresses that are likely to remain relatively permanent, required a large amount of correspondence and sleuthing. This list of clubs—the most complete now available anywhere—should be valuable to many users of "A.T.M."

The "Last Word to the Beginner" was left in and, with misgivings, that odd portrait at the bottom of it.

Wates volunteered to make another index, and now your scribe therefore has a goat on whom to lay future peeves, if any, about the index. (Probably Wates didn't think ahead that far!)

Here are the minor corrections for the main part of the book.

Page 16, line 34, after "flat is," add "one of." (We believed that—years ago.)

Page 27, line 4, delete "our greatest of all mirrors."

Page 34, two thirds way down, substitute "often" for "usually," with regard to Huyghenian eyepieces (when that was written they usually were).

Page 54, third line above bottom, delete "need not be exactly" and substitute "ought to be quite." (This shows how far the amateur standards have moved since this was written.)

Page 58, second line below Figure 47, add "at first." (That, too, was written in 1926 but won't get by today).

Page 60, in line 8, substitute IV, Figure 37.

Page 111, near middle, formula below "Substituting," the minus sign in second term should be an equality sign.

Page 344, line 30, "over" should be "one."

Page 370, fourth line above bottom, "tool" should be "disk."

Page 381, kill final sentence.

Page 382, in figure, alter denominator of formula to F—½(A—a), which Wates points out will be a little more exact, especially where large prisms are involved, as in an R.F.T., for example. Big help, Wates. And now—

Figure 2: **Gravel grader tube**

NEW method of zonal testing is offered by Cyril G. Wates, 7718 Jasper Ave., Edmonton, Alberta, Canada, in the following discussion:

The increasing popularity of short focus mirrors is making the subject of zonal testing of great importance to the amateur. Of all the mistakes into which the beginner can fall, perhaps the most elusive is the completely erroneous notion that, because a given zone or series of zones tests correctly, therefore that part of the mirror requires no further attention; in other words, that figuring may be confined to those zones which are, by zonal tests, undercorrected.

For the sake of simplicity, consider

a spherical mirror, 8" in diameter and divided into eight half-inch zones. Assume that all zones have the same focal length; that is, zero aberration. In Figure 3, *A* shows a cross-section of a true sphere. *B* represents the same mirror with all zones of exactly the same focal length or, to state the case more correctly, with all zones having exactly the same center of curvature. Than this, there can be no clearer demonstration of the fact that zonal tests are not the final criterion by which a mirror must be judged, but that each zone must be considered in relation to the zones on either side of it.

A step-by-step surface such as that shown in *B* is, of course, never encountered in actual practice. In fact, it would be impossible to make such a surface, since our method of polishing insures that each zone shall blend into

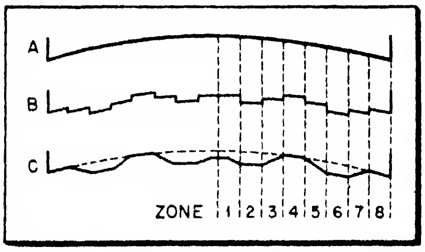


Figure 3: **Some Watesology**

the adjacent zones. We do, however, meet with such surfaces as that shown in *C*, in which zones 2, 4, 6, and 8 are exactly the same as the same zones in *B*, while zones 1 and 5 are undercorrected (short) and zones 3 and 7 are overcorrected (long). Obviously, the entire surface must be worn down to the level of zones 4 and 8, and it is also clear that zones 2 and 6, in spite of the fact that they are apparently "correct," must be polished away; and that, in a lesser degree, zones 1, 3, 5, 7 must be polished down until the entire surface coincides with the dotted line.

In an "all-over" test on a long focus mirror, zones 2 and 6 would show as raised rings, zone 4 as a depressed ring, and zone 8 as a turned edge. In the case of a short focus mirror, when it is necessary to depend upon zonal tests alone, the amateur is hardly to be blamed if he finds himself confused by the apparent "correctness" of the even-numbered zones, and is in doubt as to the practical interpretation of the readings for the odd-numbered zones.

Careful study of an excellent chapter by F. B. Wright, on page 257 of "A.T.M.," will enable the worker to draw a correct graph of the actual surface of his mirror at any time, and will prevent him from falling into the error I mentioned in the first paragraph. The results of Wright's method are quanitatively exact, but the present writer ventures to suggest a somewhat simpler method which will enable the amateur to draw such a graph without the use of mathematics.

The following table refers to an 8" mirror, $f/4$, the radius of curvature, R, being 64", divided into eight zones as before:

Zone	r	r^2/R	Case 1	Case 2
1	.25"	.001	.001	.001
2	.75"	.009	.009	—.100
3	1.25"	.024	.040	—.050
4	1.75"	.048	.085	.020
5	2.25"	.079	.110	.080
6	2.75"	.118	.155	.250
7	3.25"	.165	.165	.300
8	3.75"	.220	.220	.220

Referring to Figure 4, draw the line AA to represent the axis of the mirror. Lay out the arbitrary scale on this line, each division representing .01" aberration. It is suggested that AA may be 10" long, and each scale division ⅛".

Find the point B on the scale at one

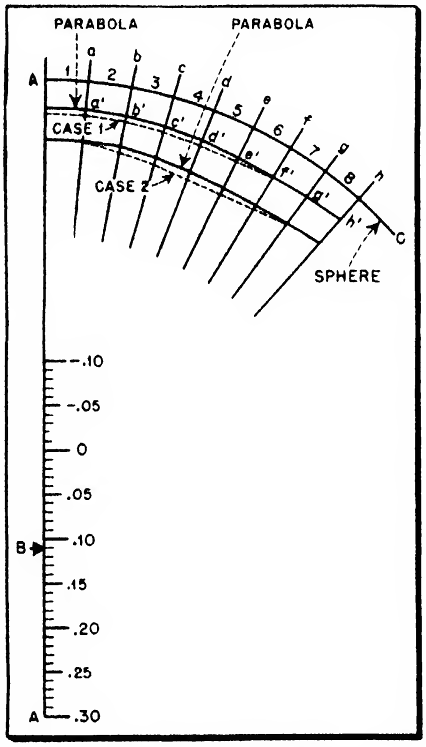


Figure 4: **Graphing a mirror**

half the total correct aberration; in this case .110". With B as a center, describe the arc AC, and lay off the equidistant points a, b, c, and so on to represent the zones. On the scale suggested these points may be about ¾" apart. Draw radii from these points toward B.

Refer to the table and note that the correct aberration of zone 8 is .220". Set one point of the dividers at .220 on the scale and the other point at any convenient place h' just within the circular arc. Prick h' and g'. Now set one point of the dividers at .165", the aberration for zone 7, and adjust the other point to rest at g'. With this radius, prick f'. Continue this process until each radius has a prick-point according to the table. Join these points with a straightedge and pencil. The resultant "curve" represents the correct parabola.

Referring again to the table, note that in Case 1, zones 1, 2, 7, 8 are correct, but that the other zones are all over-corrected. Starting at point h', prick off the points as before, taking the readings as shown under Case 1. The resultant "curve" is the actual surface of the mirror. It will be seen that the actual surface in zones 7 and 8 coincides with the parabola, but that the surface in zones 1 and 2, for which the readings were also "correct," is parallel to, but not coincident with, the parabola. It is apparent that glass must be removed from the center, tapering out to f', and that something in the nature of a small star lap, and the use of a stroke which will bring the points of the star to f', is called for.

Referring again to the table, Case 2, it will be seen that zones 1 and 8 are "correct," zones 2, 3, 4, 5, greatly under-corrected, and zones 6, 7, over-corrected. When the curve is plotted, as shown in Figure 4, it will be found that zones 1 and 8 actually coincide with the parabola, but that the rest of the surface constitutes a raised band, which is highest at zone 5. A ring lap seems to be the remedy, with a stroke which will confine the abrasive action between a' and g'.

It will have been noted that in both these cases the graph was started at the edge, with the idea of getting all the surplus glass outside the parabola, but in some cases it may be necessary to start at the center, or even at some intermediate zone. A little experimenting will soon make this point clear. If the scale and radii are drawn in ink, the various graphs may be drawn in pencil and erased as often as desired.

CLUB of amateur telescope makers—The Sixteen-Inch Club — who would, by clubbing together, obtain a greatly reduced price on 16" Pyrex disks, was announced in the July number, Clyde W. Tombaugh, Lowell Observatory, Flagstaff, Arizona, being the sponsor. Since then the club has gone over the top—gained its necessary 20 members. This reduced the cost of disks to only $35, tools to $7.80. A 16" is a nice size—big, but not too big. As we go to press we don't know whether it is, or is not, too late for others to get in on this club. To find out, if interested, write to Tombaugh.

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Turned "mountains" are what many of us get, however!

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Kodachrome, a Data Book on Photography in Color, is a 52-page book, covering every phase of photography in Kodachrome. Brought up to date to include certain changes, such as doubling in speed of Kodachrome Professional, Daylight Type, from 5 to 10 Weston, and inclusion of several new illustrations, the book provides a complete guide for the Kodachrome user. *Eastman Kodak Company, Rochester, New York, or photographic dealers.—25 cents.*

Just Another Job is a 12-page booklet which has been compiled to show the work which one organization is doing in the production of national defense equipment. A large number of photographs show industrial operations closely coupled with the production of cartridge cases and tanks, airplanes and trench mortars, battleships and scout cars. *Link-Belt Company, 307 North Michigan Avenue, Chicago, Illinois.—Gratis.*

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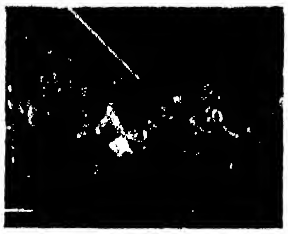

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NINETY-SEVENTH YEAR • ORSON D. MUNN, Editor

DECEMBER • 1941

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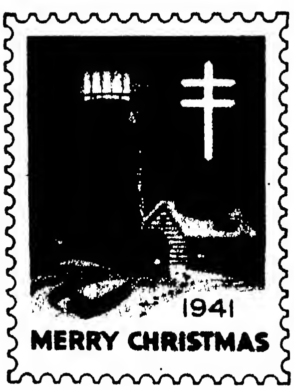

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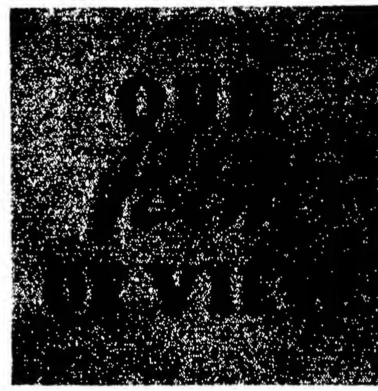

TRADE EDUCATION VERSUS CULTURE

WHY is it that in the United States, the greatest industrial nation on the face of the earth, there is a shortage of over a million skilled mechanics sorely needed to do the jobs necessary in our national defense program? Why is it that, when Congress recently appropriated 75 million dollars for the training of skilled workers in the public schools, it was found that there was no set-up for such training?

The answers to these two questions are not difficult to find, although they reveal an educational anomaly that is no credit to our much vaunted system of free public education. Then, too, the answers make one wonder whether our industrial system has not been built rather more in spite of public opinion—opinion held by those who are the greatest beneficiaries of the system—than because of it.

Answer to the first question is to be found in the fact that really skilled mechanics, those who bear the brunt of industrial production (and, incidentally, reap the rewards of this work), must be highly trained for their vocation, and that means of obtaining this training is not readily available. To attendance at the few so-called "trade schools" has been attached an odium that serves to repel those youngsters who would seek their futures in the industrial world. This has caused them to confine their formal education to the "academic" courses or to forego the benefits of advanced education completely. It has forced them to throw their lot on the industrial world with little or no preliminary training that would fit them to hold those positions which require mechanical skill.

Answer to the second question is to be found largely in that to the first, plus a bit of history in which those responsible for academic training do not play a very pretty part in the over-all picture. During World War I this nation was faced with an industrial problem similar to the one that now pertains. There was a dearth of skilled mechanics. There were no facilities for training the required personnel in the numbers needed. To remedy this the Smith-Hughes Act was passed, providing for federal appropriations for the creation and operation of trade schools all over the United States, coördinated with the industrial requirements of the localities in which they were located. These schools were to be no mere manual training set-ups, but were to be staffed with accredited mechanics who had been "through the ropes" and who had served a sufficient period in actual production work at their chosen vocations to be fully familiar with the problems that students would face when they finished their courses. The system worked and for awhile it looked as though the industrial requirements for skilled labor would be solved permanently.

But the trade schools were looked upon with disfavor by those academicians who, in final analysis, controlled the direction of our public school system. These men and women held the view that education should be cultural, that vocational training had no place in our educational scheme. Call it snobbery, if you will, but the feeling was there, and still is, and there appeared to be no permanently secured middle ground that would admit trade-school training to proceed side-by-side with cultural education.

Under the system set up by the Smith-Hughes Act, pupils of the trade schools spent half of their school time in cultural pursuits and half in study of the requirements of their chosen trade. For awhile things progressed favorably, but soon after World War I the snobbery of academic education gained the upper hand. By legal means it was decreed, in most of the industrial states, that no one could teach in secondary schools unless he or she had graduated from an accredited university. Death came to the trade schools. Cut off was their source of instruction material. Since 1925 no highly skilled trades have been taught in the public schools of the United States.

True enough, there are still so-called trade school classes in some sections of the nation, kept alive by that fraction of the public sentiment which saw the need of such education and which was sufficiently powerful to force its will on the opposition. But the opposition, being in control of education, saw to it that the trade education was reduced to the status of manual training, and that the cultural aspect continued in the ascendency. Then there are the vocational schools maintained by various industries in an endeavor to mold suitable material for their own purposes. And there are the private schools that offer special training in narrow corners of trades—automobile mechanics, Diesel engines, welding, and the like. But the combined output of these two sources of training is so small that it could hardly make an impression in the whole field of skilled labor needs, even if the training given were sufficient for the purpose.

There is only one educational source that can supply adequate numbers of skilled mechanics for present and future requirements—the public school.

Laws must be repealed that hamper the operations of the Smith-Hughes Act. Federal funds must be appropriated only for such trade educational programs as will fit present-day requirements. More public trade schools must be opened, with complete erasure of the odium that some have attached to attendance in such institutions of learning. The personnel of such schools must be composed of those who understand the needs of industry and can plan programs to meet those needs.

Only by such means can American industry continue to lead the world.

Here is no plea to side-track cultural education. Those responsible for this branch of learning have done creditable work that must not be allowed to lapse. Trade-school education must, however, go hand in hand with culture, to turn out graduates whose education is sufficiently many-sided to insure them places in our social scheme as well as in our industrial world. With such a balanced program our public-school system will reach that height of desirability to which it should rightly aspire.—*A. P. P.*

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OIL FUEL—"Though for a long time oil fuel has been used with success in forges for heating iron and steel, it is within comparatively a recent period that users have become convinced of its economy for use under boilers. Among its advantages are increased intensity of heat, lessening of labor and riddance to ashes."

PRESSURE—"An interesting experiment has been lately made by M. Chabry, of the Societe de Biologie, with regard to the pressure which can be produced by electrolytic generation of gas in a closed space. . . M. Chabry has succeeded in getting as high as 1,200 atmospheres, or about 18,000 pounds to the square inch; and the experiment was broken off merely because the manometer cracked (without explosion)."

SIGNALING—"The last of a series of demonstrations of a new method of signaling was lately given at the Naval Exhibition, London, by the inventor, Mr. W. B. Chalmers. The apparatus consists of a series of ten immensely powerful reeds, arranged to give a complete diatonic octave with a note on each side, by means of which it is, of course, possible to produce a virtually unlimited number of short groups of notes standing for letters, numerals, or whole sentences, such as are most likely to be required in a fog, or at night by two ships meeting. In many cases three notes suffice for a message that with the ordinary fog horn using the Morse code would take about half an hour to transmit."

PHOTOMICROGRAPHY—"The importance of modern photography as applied to microscopic objects is forcibly brought out by Prof. Robert Koch, the eminent bacteriologist, who employs photography with great success to bring out the most minute parts of organic and inorganic bodies. . . . 'The negative,' says Prof. Koch, 'frequently shows very fine bodies and parts, which are afterward discovered by the microscope on the object itself, but only after very hard work and under the most favorable conditions.' "

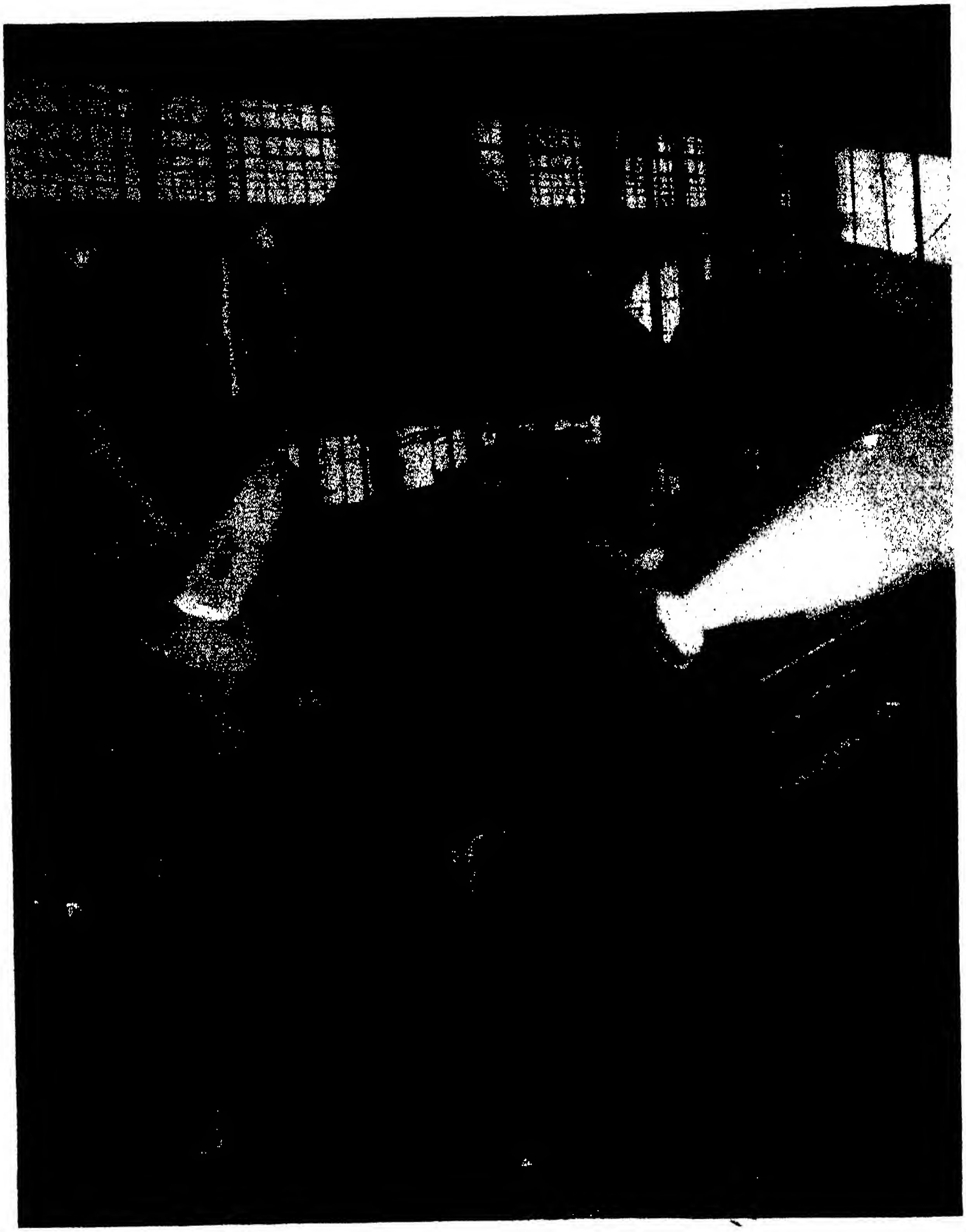
NAVY—"As the result of the efforts made during the last half dozen years, the position of the country as to means of offense and defense has been vastly improved. Not only have we the fine new vessels of the white squadron, with many other and more formidable ships approaching completion, but in the manufacture of heavy guns and armor we have about passed the experimental stage, and are now turning out both guns and armor believed to be equal to or better than any made heretofore in Europe."

POWDER—"The trials of smokeless powder are said to have resulted so satisfactorily that it is believed that within a very short time the use of gunpowder will be entirely abandoned in calibers of six inches and below, it being replaced by one of the smokeless powders."

TERMINAL—"The new terminal station of the Pennsylvania Railroad, Jersey City, N. J., opposite New York City, has the largest train shed in the world. . . It is 652 feet 6 inches long, 256 feet wide, 86 feet clear height at the center, and 110 feet from rail level to top of skylight. The structure consists of twelve pairs of main roof trusses, 252 feet 8 inches between centers of end pins, with the lower chord or tie rod running across under the platform."

SUGAR BEETS—"Among the new enterprises in Utah is the great beet sugar establishment at Lehi, with a capital of $1,000,000. . . Beets do not impoverish the land much. The constituents of the soil go largely into the leaves and crown of the beet, which are left on the ground after the harvest and subsequently plowed in. So that the farmer really returns to the soil in plowing the strength that has been drawn out of it by the growth of the beet."

ANCIENT MINERS—"A peninsula called Keweenaw Point, jutting into Lake Superior from the southern shore toward the northeast, is famous as the center of a vast copper mining industry. . . Numerous prehistoric mines have been found in this region. These ancient mines, judging from their extent, must have been worked for centuries. Who the workers were, no one can tell. They seem to have known nothing of the smelting of copper, for there are no traces of molten copper. What they sought were pieces that could be fashioned by cold hammering into useful articles and ornaments."



"TEA KETTLES" THAT SALVAGE VALUABLE METALS

RECLAMATION of metals, of vital importance to all industry, is being carried out on a large scale by Westinghouse, where there is in operation a battery of gas-air furnaces, shown above, that produces 20 tons of reclaimed metal ingots per day. Ferrous metals are first removed magnetically from accumulated scrap, then pure aluminum and copper is salvaged. The remaining metal "hash" is fed to the furnaces. Throughout the reclamation process the metals are constantly checked to make sure that the retrieved materials meet rigid requirements.

NATIONAL DEFENSE

BUILDERS FOR THE ARMY

The Engineers Put 'Em Up, Then Tear 'Em Down

DON WHARTON

THE Engineers run the greatest show in the Army. At Fort Belvoir, on the Potomac, next door to Mount Vernon, the drama, with a cast of more than 200, goes on twice every weekday except Monday.

It opens with a company of raw Engineer troops marching out on a road through the woods, halting at a defile, grabbing picks, shovels, saws, hammers, and mallets, and beginning to block a road. The troops have two hours, may use any materials at hand. They dig great holes, put in them logs two feet thick, rising upright six to seven feet, braced with other heavy logs and lashed together with steel wire.

In front of this and behind it they build other obstacles; one an odd-shaped platform to throw a tank off balance, another to tip it further, another still stronger to catch the swerving tank, stop it or turn it over, or snag it in the belly. For good measure they pile on some loose logs crazily—to roll with the tank and perhaps tangle in its track mechanism.

An officer blows a whistle—time is up—and the troops gather on the roadside to see their work tested. Not tested in theory, but by a real tank driven by a tank commander with but one ambition — to bust through what the Engineers have built. The three sergeants who are volunteers for this special duty, are altogether the most courageous men I've seen in our Army. For three months, they have seen the obstacles get more formidable each week, yet never have refused to tackle one.

Two have light tanks, one a medium. This afternoon it's the medium. Sergeant Cochrane, a Kentucky boy, has come down the road afoot to look the block over—the most terrifying thing you ever dreamed of driving into. Asked whether he can get through, he drawls: "I'm going to try like hell."

Now he's back with his tank, a quarter mile away, warming up his engine. Here at the block an officer is telling the troops that the tank may turn over, catch fire, injure the driver or kill him, but: "Understand, you are not to move." Now the tank is coming, all buttoned up with only the driver inside. The tank roars nearer, siren shrieking, making nearly 40 miles an hour and heading straight at the logs, any one of which would wreck the 20th Century Limited.

Cochrane hits the first block, swerves, plows on through the second, hits a third sloping mass, jumps toward the sky. Its belly nine feet off the ground, the 25-ton tank flies 30 feet through the air, crashes down, splinters oak and pine, thunders into the last obstacle—and stops. A tremendous happy cheer rises from the Engineers, and then silence, from them and from the tank. Its motor is dead and it doesn't move. The Engineers, remembering their orders, stand where they are.

A tank trooper races to the silent monster, climbs up, looks in—and everyone wonders whether the man he's looking at is dead or alive. Actually, he's unconscious but in a long moment he comes to, crawls out, lights a cigarette, and stands there rubbing his back. In a few hours he's in a hospital bed—wrenched back—and the Engineers are out on the field learning something more.

Next morning another Engineer company is building another road block and Sergeant Sims is hitting it with a light tank which is stopped upright on its tail, gas pouring from a broken line while the Engineers yell and a tank trooper runs up with a fire extinguisher. Then it's Sergeant Griffin's turn.

Out at Fort Knox, where the Armored Force trains its Engineers, you can see another good show. You drive a few miles to Salt River, park, stumble down a hill in the dark, and begin to glimpse black forms weaving back and forth. Here are Engineer troops who marched out from their barracks this afternoon, slipped across the river in assault boats, established a bridgehead and built two floating foot-bridges. Then they built a pontoon bridge for light tanks.

FIVE minutes after completing it they tore it down. That was in daylight. Now, stripped to their shorts, they are building it in a blackout — no cigarettes, flashlights, moon, or stars. They have been in the Army only eight weeks and the Germans reckon two years as the minimum for training Engineers. They have never built a pontoon bridge until today; their officers, reservists, are themselves a little green. Yet in the darkness they span 170 feet of river in two hours and 50 minutes—70 minutes faster than they did it in daytime, experience being more valuable than light.

Five minutes after finishing it

Photo by U. S. Army Signal Corps
The "Hairy Ears" strive to construct a sure-fire tank-wrecker

they begin tearing it down again. Then the Engineers in B Company come out of their tents nearby, build the bridge in the dark, tear it down in the dark, wait for dawn, build it again, tear it down again, and with A Company march back to barracks.

Thus our Engineers prepare for war. Except for the Air Corps, they are the Army's fastest expanding branch. They now number some 70,000 — nearly half the total strength of our Army when war began. Tanks, planes, and parachutes get the front page, but our Army, watching a single barometer, know that Engineers are playing just as big roles in this war. Their barometer is the German decorations list.

It was Engineers who forced the surrender of Belgium's great Fort Eben Emael, destroying the myth of impregnable fortifications. It was Engineers who constructed bridges on which German tanks crossed the Meuse, and thereby made possible the Sedan breakthrough. (Contrary to popular belief, the French *did* blow up the strategic Meuse bridges.)

British Engineers helped make the Dunkirk evacuation possible. Demolition accomplished by a relatively small group of them slowed the Germans down.

Mechanized warfare has doubled and re-doubled the importance of the Engineer. The tanks got armies out of the trenches, but it takes Engineers to get the tanks across streams. Bridging is their No. 1 job. The Engineers with a single German Army on the Western Front built 57 pontoon and 183 semi-permanent bridges in a few weeks. Not only must engineers in this war build more bridges, but also they must build them faster and stronger.

In 1940 we had no pontoon bridge for the medium tank. Today we have one in use which some think is the best in the world. The wooden sleepers and flooring are made of selected Douglas fir; the boats are aluminum; all are carried on semi-trailers which can roll along at 45 miles an hour—twice as fast as the Germans can move their equipment.

But we haven't stopped there. Early this year Colonel Lunsford E. Oliver and Major Thomas H. Stanley challenged the military maxim that pontoon bridges should be made of parts small enough to be man-handled. Our Engineers, Germany's, Britain's—all believed this. But hadn't mechanized warfare made the axiom obsolete? Why not steel treadways instead of wood?

Colonel Oliver wrote to Washington. Washington at first said "No," but finally agreed and by August the new bridge was a reality: steel treadways supported by rubber boats. It is transported by special trucks, equipped with cranes. More than a thousand feet of the bridge is now being turned out.

At Fort Knox I watched them build a section of this bridge. I had seen crack Engineers put up our standard bridges; by comparison this one was amazing. A Canadian Engineer came up, so I checked with him. The Canadians, British, Russians, Germans—none of them, he said, had anything to touch it. To bridge 300 feet of river under average conditions takes 200 men some five or six hours; with this new bridge 25 men can do it in two hours—maybe in one. It will even carry the 60-ton (heavy) tank—something no German pontoon bridge will do.

A span of the new bridge makes an excellent ferry—to get a few tanks across quickly and into action while bridges are built for the main tank thrusts.

During the World War an American Engineer regiment marched afoot and worked by hand. Today each regular Army division has a

Photograph by Photo Section, 4th Armored Division
By pontoon ferry, engineers transport a tank across a river

battalion of 634 Engineer officers and men which moves entirely on wheels and works largely with power tools. One piece of its equipment is a motorized air-compressor unit which will do everything except whip up a salad. They hook a saw to it and cut standing timber for bridges and barriers; with another tool it drives railroad rails into the ground—more barriers; other appliances excavate, break pavement, build machine-gun emplacements, spray paint for camouflage. It has an automatic nail-driver for quick construction. It can pump water fast. At Fort Bragg, an Engineer platoon with this unit and a bull-dozer completed a crossing over a 120-foot swamp in 18 minutes.

Photo by U. S. Army Signal Corps

Mobile water purification unit, with elevated storage tank, at right

The Engineers have mobile earth augers which race along at 50 miles an hour and can bore holes nearly two feet in diameter. The Engineers have the vital job of producing the maps for the army in the field; one small maneuver last year required 24,420 maps. They have mobile map units with high-speed printers which can operate a thousand miles from civilization. They also have a unit which can drive up to a muddy stream and in a few minutes be delivering enough clear, purified water for 4000 men. They have developed a portable overpass—invaluable when one column of troops must cross another's line of march. They have even developed a portable hot-water shower.

To train men in handling themselves and equipment under difficult conditions they have developed an obstacle course that includes a hurdle, a ditch jump, a smooth wall, a four-foot breastwork, and a field of old auto tires. Besides, the human steeplechaser must swing by a long rope across a ravine, jump a fire trench, cross a stream on narrow stringers, climb over 12-foot ladders, and through barbed wire and long culverts. The men are sent through in groups of five. They make a game of it. Sometimes they compete as individuals and groups, sometimes run against the stopwatch. Gradually they build up to running in field uniform, under pack, carrying the rifle. Other camps have adopted this Engineer development, and at Pine Camp a medical unit raced through it carrying stretchers.

Some officers say the Engineer's No. 2 job is laying anti-tank mines—the only portable obstacle which armored forces really fear. To develop the best pattern for laying mines, tanks were driven by remote control over live mines. The troops now use little smoke mines for practice, and see with their own eyes how good their work is when a tank tries to get through their pattern. Instead of practicing at night, the troops wear black goggles.

The "Hairy Ears," as the army song calls them, learn by doing. They have bought a 58-mile railroad in Louisiana to practice with. Come war, the Engineers may have to operate railroads—they did last time. Few experienced railroad men are of military age. On the practice line, green men are taught railroading. The Engineers are extending the line 20 miles—more practice. Regularly, they blow up part of it, to practice quick repairs. Also, they are testing in actual operation the light locomotives and cars the army has developed because World War I experience taught them that our standard equipment is too heavy for use near the front.

At Fort Belvoir, Engineer troops every day build crude shelters designed for troops near the front line. They are timed as they put up the shacks, timed as they tear them down again. The nails they use have two heads, one above the other. Driven in until the lower head is flush, they are easily pulled out by the upper projecting head. The lumber is used over and over.

Some months before we moved

Photo by U. S. Army Signal Corps

Warm weather or cold, the Engineers must build pontoon bridges

into Iceland, one Engineer battalion practiced building "arctic" barracks out of prefabricated parts; the commanding officer had the men wear their barbed-wire gloves to simulate the all-thumbs effect of mittens. A few weeks ago a company commander at Belvoir found his men putting up barbed-wire sloppily—Monday morning apathy. He let them finish, called them to attention, told them it was such a

Photograph by Photo Section, 4th Armored Division

They're boatmen, too. Men in bow and stern are engineers

poor job he was going to tear it down with his bare hands. He did—then ordered them to put it up again. This time they went at it with pep and proficiency.

In Virginia they have built little Maginot Lines of pillboxes which they have scarred and blackened in practice assaults with flame-throwers, grenades, anti-tank guns, and explosives placed with poles. In southern Illinois, last spring, they found a stretch of old U.S. 13 which was to be flooded by the Crab Orchard Dam and practiced blowing craters in it. They used up three and one half tons of exposives, putting charges deep and shallow, close together and far apart, until finally they got a combination that blows craters with steep V-shaped sides which will stop a tank. Most craters will not. Since then the Engineers have tried this combination some 200 times on the varying soils of California, Georgia, Texas, Louisiana, and Panama—testing each crater with a tank.

They are also carrying on a great hunt for new ways of handling enemy mine fields, have experimented with rollers attached to the front of tanks, and are now working on a detecting machine, such as the Germans are supposed to have, which looks like an overgrown lawnmower.

Camouflage is another Engineer responsibility. They are not only working out techniques, but testing them. At Belvoir, they made models of two of our air bases so that from a high water tower they photographed the same as the bases themselves from 10,000 feet. As a result, they learned enough to halt the construction of one of our new bases, and have it completely redesigned. The Engineers are building their own new center near Belvoir—a $2,500,000 job—so that it will be virtually invisible to aerial observers.

In New England, they are camouflaging an air field in another great test; leaving tobacco barns and groups of trees in the field, building a parachute tower to look like a church steeple, putting in a false cemetery, eliminating the usual row of hangars, continuing a railroad siding far beyond its natural end, painting a dummy highway right across the landing strips, and even having sections of the field plowed at different angles and sown with different grasses to make it look like innocent farmland.

Meanwhile, they are carrying on the work they always have to do—the building for the Army. In ordinary times, that alone is considerable; just now it is a billion dollars' worth of construction—air bases from Alaska to Puerto Rico, sea-coast defenses, the new set of locks at Panama, these are items on the list.

Not having been at war, our Engineers have no Eben Emaels and Meuse River crossings to talk about. But thanks to the ingenuity of some Engineer officers, the troops are getting wide-awake training plus tools which will probably prove to be superior to those used by the Germans.

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BRITISH INGENUITY

Foreign Correspondent Tells Of War Aids

An interesting letter recently received from A. P. Luscombe Whyte, of England, outlines some of the constant research which is being carried on in England today. That the post-war world will benefit from the experiments of today is obvious from the following excerpts:

A suitcase radio transmitter for marine use has been developed which is compact, waterproof, and buoyant. When a ship is torpedoed or otherwise damaged and has to be abandoned, the unit can be thrown overboard where it will float until picked up by one of the ship's boats. The device is automatic.

A new type of life-saving "waistcoat," which can be worn day and night by passengers and crew members when the ship is in a danger zone, has been introduced and its use made compulsory. It is a sleeveless jacket containing 16 ounces of kapok. Although it is light and thin enough not to hinder ordinary work or to interfere with comfort, it will support the wearer and a comrade clinging to him.

Life boats themselves are now being equipped with one-man hand pumps which can rapidly empty a flooded boat. New types of concentrated foods and thirst quenchers have been developed for inclusion in the food stores to be carried by every boat.

By such means, and by similar applications of ingenuity, something of the dread can be removed from the order "Abandon Ship."

ANTI-AIRCRAFT

First Mount Built By Private Industry

Preliminary work has been accomplished and large-scale production is now starting on the first 90mm anti-aircraft gun mount to be built by private industry in United States. In this mount, shown in a photograph on this page and on our front cover, produced by the Allis - Chalmers Manufacturing Company, 3858 separate parts compose the delicate mechanisms on which the gun depends for its extreme accuracy and great mobility.

It is claimed that this new gun is capable of blasting planes out of the stratosphere nearly seven miles up. The units can be unlimbered from traveling position and put into firing position in six minutes.

New plane-blaster

Physics Scores an Assist

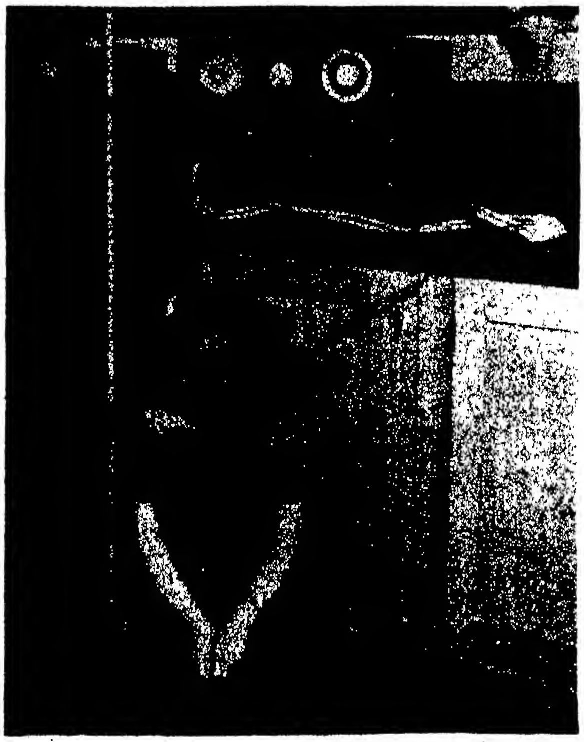
The Particle Detector, Teamed up with the Cyclotron, Gives Medicine a Powerful Tool

JANE V. SHEPPARD

PHYSIOLOGY teachers in grammar school used to combine instruction with entertainment by telling us that the food we ate did not retain its original structure once it got into the body, so that you could not expect to find a boiled potato floating serenely down the blood vessels in your arm or a pork chop wending its way through the muscles of your leg. We learned that digested food was broken down into different chemicals and distributed about the body; but just where each chemical went, and in what proportions, was rather difficult to determine by the direct chemical methods formerly employed. These methods required the administration of such large amounts of a given element that the abnormal dosage was likely itself to disturb the whole body metabolism and give false results for the experiment.

Today, modern physics has given biologists and medical research workers a remarkably versatile new tool with which to unravel the mysteries of metabolic processes, not only in man but in plants and insects as well. The knowledge made available through these new studies has vast implications for the improvement of human nutrition; for the treatment of abnormal states of body metabolism—notably malignant tumors and glandular disorders; and for increased control over the lives of plants and insects.

The first step in the new method for tracing the atoms of elements administered to plants and animals is to synthesize artificially radioactive elements into chemical compounds which can be taken into the living body, and followed to its parts by means of detecting apparatus. Irène Curie, daughter of the famous Madame Curie, and her husband, F. Joliot, were the first to discover, in 1934, the process of making stable elements into artificially radioactive isotopes. Transmutations of the atomic nucleus, brought about by bombarding atoms with high speed particles, will set up an unstable condition in the nucleus, with consequent emission of positive or negatively charged electrons, sometimes accompanied by gamma rays, depending on the particular element used, and the new cyclotron is already being used to good advantage to bring about these nuclear transmutations. Since a radioactive isotope is chemically identical with the stable element from which it is formed, it can replace the stable element in compounds which normally enter into the constitution of a living body, yet make itself known by its emissions.



Counter measures radio-iodine in the thyroid

In former experiments radium was used as a tracer, but this was not only dangerous but also limited in scope. Radium decays into other radioactive forms through a continuous series, so that any radium taken into the body will be giving off radiation for many years. Furthermore, radium is not a normal constituent of the body. In contrast, many of the new artificially radioactive elements do not emit radiation for a long period of time and they decay into stable elements which do not give off any radiation.

There are three ways of tracing the course of radio-elements in the body: tissue assay, autoradiography, and experiments in the living organism. These will be considered in order.

The radiations from radioactive substances can be detected by bringing the substance close to a Geiger counter, a physicist's instrument which records the impinging particles and gamma rays in a series of staccato clicks. If now you feed your pet mouse on some food containing a radio-element, and then dangle him in front of such a counter, it will emit a rapid stream of dot-dot clicks. Your pet has become a Super-mouse capable of throwing any near-by Geiger counter into a chattering panic.

NOW let us apply the process on a larger scale. If we give a dog some radio-element, and kill him after a few hours, we can disorganize him and test each separate organ and body fluid near a Geiger counter to see just which tissues have snatched the larger portions of the given element. This is known as tissue assaying. If the original substance, before being added to the canine menu, gave a count of 100 per minute, and the liver of the dog which has partaken of the tagged substance gives a count of 10 per minute, then we know that one tenth of that substance was commandeered by the liver.

Neat tricks like this are yielding valuable evidence as to just what becomes of the food we eat and what elements are most needed by the various tissues of our body, and these things are of fundamental value to medical science. For example, Dr. Borsook, at the California Institute of Technology, has

directed some significant studies on the disposal of vitamin B_1 by the body by preparing this vitamin, which contains sulfur normally, from radio-sulfur.

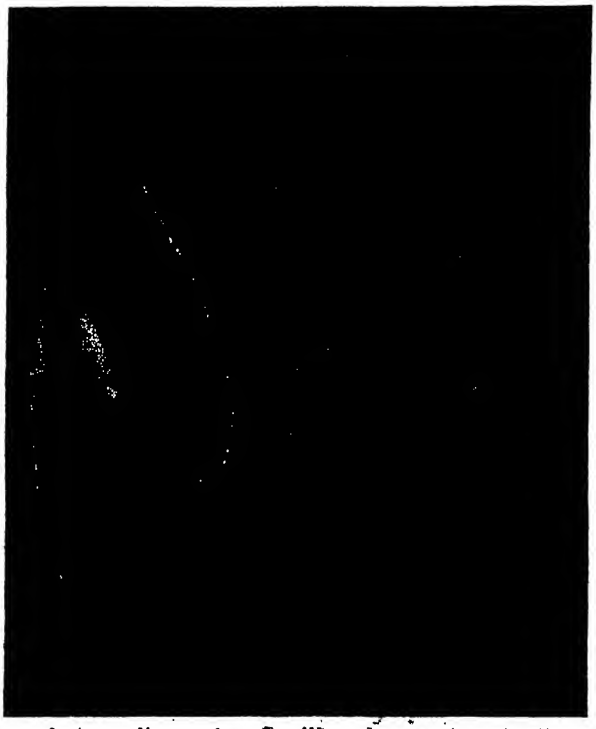
Another means of tracing the line of march and mass concentrations of radio-elements in an organism is to make auto-radiographs of tissue sections. After administration of the element, the animal is killed, and very thin sections of tissue are prepared from the organ to be examined. These sections are placed on a photographic plate and left an adequate time for exposure. Radiations from the tissue will act on the plate just as ordinary light does. The plate is then developed and the darkened areas indicate where the radio-element has been most concentrated.

Now the tissue section itself is stained to show up its cell structure. The film and the stained tissue are examined under a microscope to determine exactly which cells have taken up most of the radio-element.

This method is applicable to plants, animals, and insects. Metabolic studies of insects were formerly very difficult because of the minuteness of the experimental subjects. Now insects can be fed radioactive salts, thin sections of the entire insect prepared, and auto-radiographs made to find out just where the salts have accumulated. This method has important commercial applications for it can be used to test the effectiveness of insecticides.

Fortunately, we have still another method available for tracing the path of radio-elements in the human body without eviscerating the subject or making chipped-beef sections of his interior. This method is made possible by the gamma-ray emission of many radioactive salts. After administration of the salt, a Geiger counter is put over the region of the body where you want to detect an accumulation of tagged elements. It has been found that salts of sodium and calcium, when taken by mouth, appear in the tissues of the hand within two minutes. This is determined by having the subject grasp a counter tube in his hand, with the forearm enclosed in a lead box to shield the counter from radiations from other parts of the body.

The most extensive experiments using radio-elements have been conducted with phosphorus, iodine, calcium, strontium, carbon, and nitrogen. Radio-phosphorus administered to mice was found to be concentrated largely in the bones. K. G. Scott and S. F. Cook, working at the University of California, at Berkeley, were impressed by the implications of this experiment and reasoned that if radio-phosphorus tended to accumulate in the bones, large doses of it would irradiate just these tissues and affect them much as X-rays affect body cells. Using chicks as their experimental media, they confirmed their notion that radio-phosphorus would act on the bone-marrow, the chief blood-making tissue of the body, and would decrease the number of blood cells in the circulating blood.



Auto-radiographs of willow leaves (see text)

This seemingly innocent experiment may lead to the forging of new clinical weapons for combatting two mysterious blood diseases. The first of these, polycythemia vera, is a disorder of the blood in which red cells increase to an abnormal level for some unknown reason, and it now appears highly probable that radio-phosphorus can be used in such cases to irradiate the bone marrow and reduce the number of red corpuscles. The other disorder is a leukemia, in which white blood corpuscles increase to a dangerous level. It has already been found feasible to treat mouse leukemia—a disease in all ways similar to the human leukemia—with radio-phosphorus, and clinical procedures are now being conducted to explore the possibilities of using this treatment on human beings.

Radio-phosphorus has also been used to differentiate malignant tumors from normal tissue. The nuclei of tumor cells accumulate more labeled phosphorus than normal cell nuclei. In fact, many radio-elements are absorbed at a different rate and in different amounts by tumorous tissue than by normal tissue. It is to be hoped that these differences will lead to further knowledge of the origin and cure of tumors.

Biologists have made surprising discoveries about the movement of nutrients in plants by putting radioactive salts of phosphorus around the roots of plants and trees. It was found that both the anions and cations of salt were carried to the leafy part of a tree by means of the wood rather than the bark. The cells of the bark draw their nutrients from conducting vessels in the wood. Whereas it was formerly believed that nutrients could move only from the roots to the aerial portions of a plant, it has now been shown that they can also move from above downward. Radio-salts of phosphorus, painted over a limited area of a willow leaf were absorbed and spread to adjacent leaves. This process was observed by making auto-radiographs of the leaves. In the illustration the dotted lines indicate how the leaves were laid on the photographic plate. The bright area at the left is where the radio-phosphorus was painted on the leaf, and the faint central line proves how it traveled down the central vein of the leaf, through the stem and to adjacent leaves (very faint line, partly due to loss in reproduction). This proves that plant nutrients can spread from leaf to leaf as well as from roots to leaves.

Experiments using radioactive

iron salts have added to our knowledge of anemia. G. H. Whipple, at the University of Rochester, experimenting with normal and anemic dogs, found that the anemic animals absorbed far more iron than the controls, and that a larger proportion of the iron was concentrated in the blood cells. He also found that the absorption of iron depends on tissue depletion of iron and not on the existence of anemia alone. If dogs were bled freely and then fed iron salts, they absorbed iron at the same rate as normal dogs; but if a few days were allowed to elapse, during which the blood could draw on the iron reserves in the muscle tissue, then the anemic animals took up a large portion of iron to restore their tissue reserves.

As MIGHT have been expected, experiments with calcium proved that it is largely concentrated in the bones and teeth. Since this element accumulates in the bones to such an extent, it would seem possible to use the radiations from radio-calcium in the treatment of bone diseases. But calcium remains radioactive for too long and it has weak beta-ray emission. Fortunately, strontium has the same distribution as calcium in the body and has the added advantage of rapid decay and strong beta-ray emission. Possibilities of clinical therapy using strontium are now under examination.

At the University of California, S. Ruben and M. D. Kamen, using radio-carbon in the synthesis of carbon dioxide, discovered that plants can assimilate small amounts of carbon dioxide from the air even in total darkness. However, the synthesis of plant nutrients does not proceed beyond a certain point in the dark, and requires sunlight for the reactions to go to completion. These new studies on photosynthesis suggest that simple sugars are not made directly in plants, but that they are split off from large molecules built on a plant enzyme whose chemical make-up has not yet been deciphered. These recent studies on plant metabolism will probably lead to improved methods of plant culture.

The use of radio-nitrogen in experiments on plants may yet upset some of our former views on nitrogen fixation. When barley plants were exposed to atmospheric radio-nitrogen, some of the labeled nitrogen atoms appeared in the plant tissues. Whether the plant merely exchanged some of its own nitrogen for the atmospheric nitrogen, or whether it actually succeeded in fixing some of the radio-nitrogen, remains to be determined. It would be quite a surprise if it were found that non-leguminous plants can fix nitrogen.

Radioactive iodine has so far proved to be the master detective in this brilliant new group of metabolic sleuths. The use of radio-iodine has led to some unusual revelations of the secret goings-on within the thyroid gland. Iodine is essential to the synthesis of the hormone, thyroxin, which regulates the oxidative processes of the body. The thyroid gland has an amazing ability to capture and concentrate iodine. Other tissues of the body contain less than 5/1000 the amount of iodine found in the thyroid. The concentration of radio-iodine in this gland is tested by placing a Geiger counter over the throat above the thyroid. The rate of accumulation of iodine varies considerably in normal people and those with thyroid disorders. In hypothyroidism the uptake is very slow, in non-toxic goiter it is quite rapid, and in hyperthyroidism iodine is quickly accumulated but is lost at an equally fast rate. It is still doubtful whether this technique of diagnosing thyroid disorders will replace those now in use. Auto-radiographs of thyroid tissue after administration of radio-iodine show that the iodine is evenly distributed in normal tissue but is distributed in a characteristic pattern for each type of thyroid disorder.

The use of biological tracers will doubtless be even more widely applied since the recent discovery of how to make radio-carbon 14. Since carbon enters into practically all organic compounds, the existence of artificially radio-active forms of carbon is most important. Formerly, physicists could make only carbon 11 in limited amounts, and it decayed so rapidly that the biologist had to be a track star to work with it. Now, with the aid of the cyclotron, carbon 14, which decays very slowly, is made available in generous amounts.

If physics has done a good turn for biology, the favor has not gone unrewarded. Not long ago, the physicists were casting around for some means of proving that a newly discovered element, element 85, was really eka-iodine. Since it was closely related to iodine it was reasonable to expect that it would be concentrated in the thyroid just as iodine is. Radioactive element 85 was fed to mice and was found to be strongly concentrated in the thyroid, proving that the new element was actually eka-iodine.

Thus, in the application of radioactivity to the solution of practical problems of biology, we come to another of the many instances in which pure science ultimately contributes, perhaps unintentionally but nonetheless beneficiently, to the progress and welfare of human life.

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THIN FILMS

Find Varied Applications In Scientific Research

FILMS of synthetic resins, some composed only of 10 to 15 layers of molecules, are proving a useful tool of science, according to Vincent J. Schaefer, of the General Electric Research Laboratory.

The thinnest films, he explains, are useful for mounting specimens in the electron microscope. Somewhat thicker films are valuable in studying characteristics of the resins themselves, as they react more quickly than larger amounts of the materials. For instance, Mr. Schaefer has found effects of ultraviolet light on films in a few minutes, where hours are required with thicker samples.

Pointing out another possible use, he says that, treated with zinc sulfide, the films make highly efficient "beamsplitters." These are used in optical instruments, where it is desired to divide a light beam, reflecting part to the side, and sending the rest on its original course. Partially silvered mirrors are usually employed, but these lose about a third of the total light. In contrast, only a twentieth of the light is lost with a film beam-splitter.

In making the films, Mr. Schaefer takes a clean glass slide and dips it into a solution of the resin. Then he withdraws it and lets the liquid dry, so the film forms on the slide. He scores with a needle point the part wanted, dips it in water, and the film floats off. The film is then perfectly dry, he points out, as the water slides off.

"Make-up" for Better Seeing

Studies Show that Safety can be Increased, Production Speeded, Workers Made Happier

A. P. PECK

AN ATTEMPT to improve seeing conditions for the operators of a huge press in an automobile-body fabricating plant pointed the way to research that is resulting in what may prove to be at least a small revolution in preconceived ideas regarding lighting in industrial plants in particular and in offices and other places of business in general. Piling up the illumination level at that press did not do the required job. After illumination reached a certain optimum, added wattage had no further desirable effect. Then light-colored paint was tried on the press itself. Immediately it was found that the newly introduced reflecting surfaces—the painted parts—so greatly supplemented the light source that the working parts of the press could be seen easily and accurately by the operator, in their correct relationship to the material being fabricated. Safety increased, production stepped up.

Here was something for lighting engineers to conjure with. It recalled the story of the New England shoe manufacturer who, a dozen years ago, was having a bit of labor trouble. His workers complained of frequent headaches, of spots before their eyes. Investigation showed that these men, working with black leather on black machinery, had to strain their eyes to distinguish their materials from a non-contrasting background. Paint the machinery a lighter color, any color, was the order. Accidents, so the story goes, fell off nearly 70 percent. The workers felt less fatigued, suffered less frequent headaches, saw fewer spots before their eyes.

Other examples of such hit-or-miss applications of color contrast to industrial jobs could undoubtedly be found, but it took the fine hand of research, intelligently applied, to bring forth an array of data upon which could be built a new corner of the science of seeing. Starting with the example of the painted press in the automobile-body plant, Arthur A. Brainerd, Director of Lighting Service of the Philadelphia Electric Company, decided to investigate the possibilities of improved seeing through the application of paints of various colors to surfaces which, in the past, had been painted in conventional colors selected with little or no thought to ultimate lighting utility.

"Spotlighting" the tool-working area of a punch press with light buff to produce better seeing

Engineers and laymen alike have known for many years that white walls and ceilings in a room will reflect light, will provide better illumination than when these same surfaces are dark in color. Little attention has been given, however, to color *contrast* in relation to ultimate seeing, and it is this contrast that has been found to be the key which opens many doors to better seeing.

As Mr. Brainerd progressed in his work, he found need for collaboration with experts in the surface-finish field. Such collaboration was obtained from E. I. du Pont de Nemours Company, the resulting research team working hand in hand to acquire the basic knowledge which has resulted in practical applications of what the researchers term "three-dimensional seeing."

Briefly stated, the basis of this new phase of the science of seeing depends on the fact that the eye is naturally attracted to the brightest area in the field of vision. Yet machine tools, such as the press previously mentioned, are generally painted over-all in solid, drab colors that do not attract the eye and that offer no color contrast to the material on which the operator is working.

WITH these points in mind, the researchers selected two typical machine tools on which to conduct a series of intensive studies, the huge press that started it all being in constant production use and hence not available for continuous experimental work. A small punch press and a power shear, located in an active machine shop handling a wide variety of work, were the two units that became the guinea pigs of the research. In order to arrive at conclusions that could be applied under varying conditions, the two units were arranged so that they could be illuminated by either incandescent or mercury lighting equipment at will. Photometric records were made of each of the colors tested, the readings being taken of light falling on the working surface and of light reflected. The original color of the machines was a standard battleship gray, a color that reflects a relatively small amount of light falling on it. Periodically the machines were painted with different colors in semi-gloss, oil-resistant, washable machinery paints, a complete series

of tests being made with each color. These tests included light measurements, time studies, and psychological reactions of machine operators.*

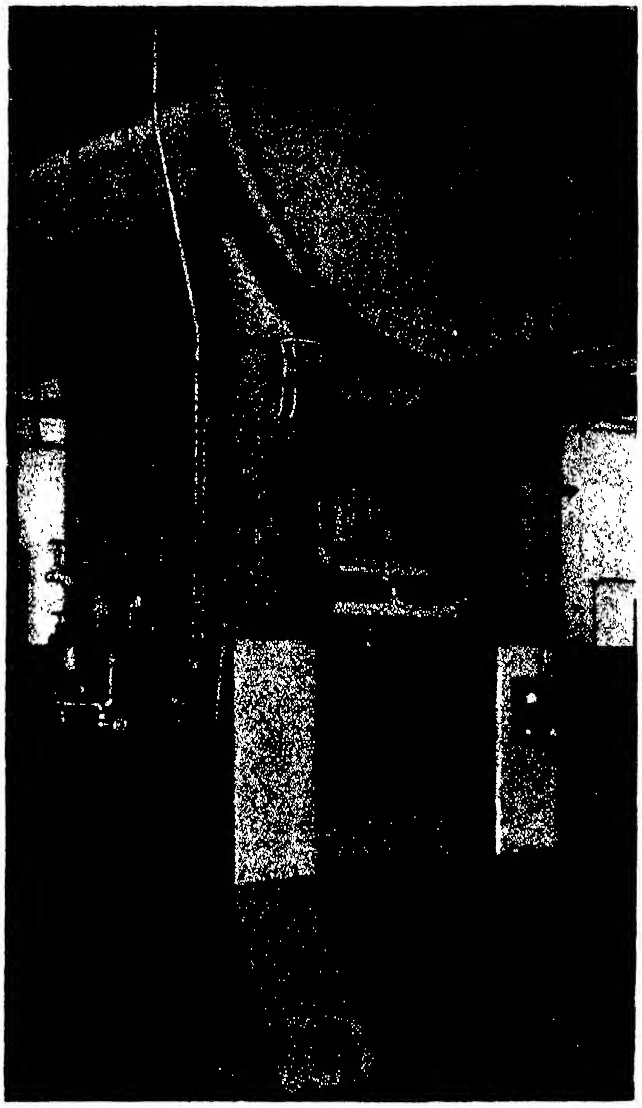
When these experiments were started, the paint was applied to the entire machine. Included in the colors tested were battleship gray, aluminum, light green, light gray, yellow, light blue, light buff, and medium gray. These colors were accurately reproduced on a sample chart and liquid samples of each paint were kept for future reference and testing. As a further check on one of the minor but important problems involved, small metal samples were painted with each color and placed around the shop in rather dirty locations. Periodical examination of these samples enabled the engineers to determine the durability of the paints under shop conditions as well as their adaptability to maintenance.

When sufficient data had been accumulated regarding light-reflection characteristics of the various paints under operating conditions, it was found that, contrary to what might be expected, the aluminum finish rated very low under incandescent lighting. The researchers state that, thus far, they have no explanation for this fact. In any event, however, light buff showed up remarkably well under both incandescent and mercury lighting. Light gray and aluminum rated about equally well under mercury light but under incandescent the light gray far outstripped aluminum in reflection characteristics. Light green was high enough in its rating to warrant further consideration, and the other colors tagged along with values that put them out of the running.

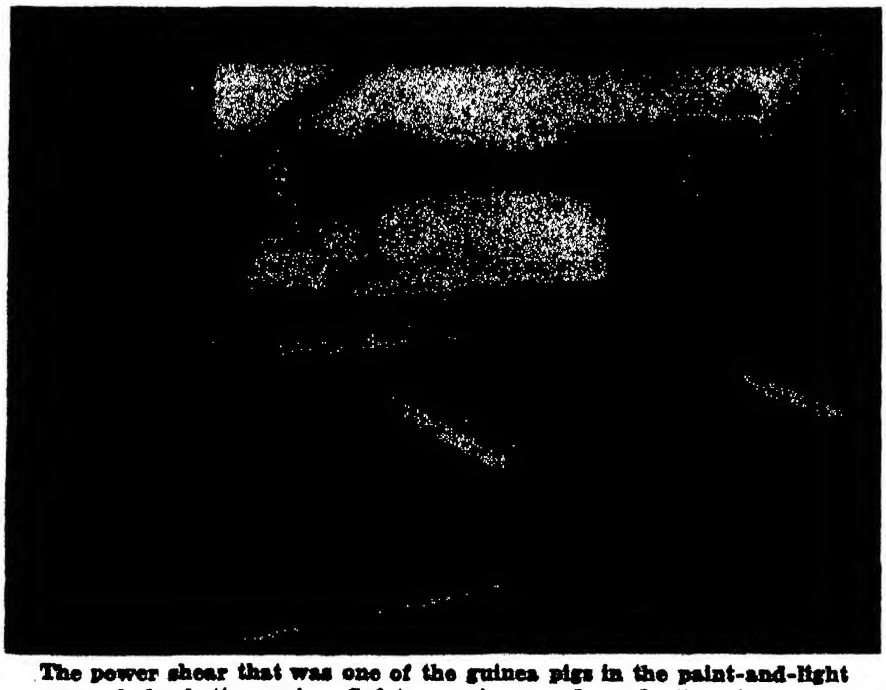
This brief summary of results is generally correct for both machines employed in the experiments, although the same colors sometimes reacted differently when applied to the punch press than to the shear. This fact alone indicates that additional investigation will undoubtedly reveal that this form of "three-dimensional seeing" will have to be varied somewhat to suit the immediate application. Basic rules can already be formulated, but the greatest benefits can be achieved only when these rules are varied for the job in hand.

Time studies with the two machines closely paralleled the light studies. Conducted with a group of workmen performing simple jobs under routine conditions, the light buff stood highest on the list. Jobs timed in seconds were accomplished more rapidly when the machinery was painted in this color than when other colors were used. This superiority held true under both types of lighting used. Oddly enough, however, medium gray showed up surprisingly well for certain tasks, in some cases leaving little to choose between this color and buff. Light green and light gray were also about equivalent, but lower on the time

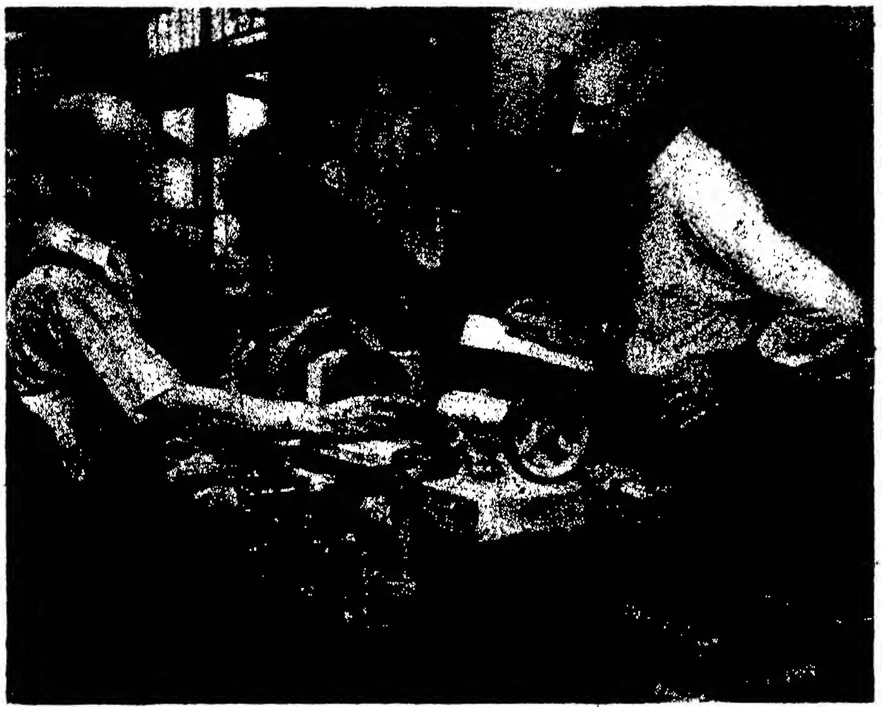
*Interested readers will be referred upon request to additional sources of information on this whole subject of "three-dimensional seeing," in which the tests are described in detail, with explanatory charts and tables.



Dark areas are painted gray, light areas buff, giving "three-dimensional seeing" at this huge press



The power shear that was one of the guinea pigs in the paint-and-light research for better seeing. Safety was increased, production stepped up



A machine-shop lathe painted in accordance with the findings of research. The stereoscopic effect so obtained is particularly noticeable here

scale than the other two colors mentioned. Again aluminum was low.

Psychological studies of the paints for various operations were made by the questionnaire method. A group of 15 men, including two foremen, were asked a series of questions about each color used. These questions included: Is the paint more or less tiring than original? Can you see better than with original? Can you work faster than with original? Is it easier to do better work than with original? Do you need more light? Do you think it's safer than before?

Once more a striking parallel was found. Light buff and light gray were voted less tiring than the original by all of the men, with the other colors ranging downward in popularity to yellow, which every worker considered more tiring. Buff, light blue, light gray, light green, and aluminum all received a 100-percent vote for better seeing than with the orginal color. Buff did not do so well with the third question, but light gray and aluminum stood high. About the same ratio held for the fourth question, while light buff and the grays were the outstanding colors with which the workmen did not feel that they needed more light to do their assigned tasks. All of the lighter colors received high safety ratings from the men, with medium gray and light green the lowest on the worker's safety scale.

With these three groups of data —reflection characteristics, time studies, and psychological reactions —in hand, the experimenters next compiled a composite rating for all the colors used. Thus it was possible to balance all factors and arrive at a result that should indicate which color gave the best all-around seeing. Under both mercury and incandescent lighting buff was rated at 100 percent, with light gray next under incandescent lighting and aluminum next under mercury.

Throughout the experiments it was necessary to make compromises, since the end-result sought was a practical one rather than theoretical perfection that could not be achieved in practice. Thus, the ideal reflecting surface for any color is a flat paint that gives a high degree of diffused light reflection, rather than a glossy surface that produces reflected glare. But flat paint is difficult to keep clean under field operating conditions and soon loses much of its reflecting qualities. Therefore a semi-gloss paint was selected as giving a minimum of maintenance problems, yet not producing sufficient glare to give trouble from this source.

Another compromise had to be made when the results of the experiments were laid before the supervisory force of the machine shop for criticism. The main comments were that, while the idea was good from a theoretical standpoint, it was not practical to paint machinery such a radical color as light buff. The machines would require too much maintenance, would have to be cleaned too often in order to keep the color effective. Accordingly, a group of machines were painted medium gray with light buff around the working areas. The purpose of this compromise was to retain the luminous possibilities of the lighter finish and still satisfy, at least partially, the requirements of maintenance.

Here came the big surprise of the whole series of experiments. The combination performed better than any of the solid colors. Additionally, it has been found that mechanics who have been working for a long period of time with machines painted in this combination will keep the light area clean without immediate supervision.

Continuing studies of the problem of industrial lighting as affected by machine color have established the following facts: Soft color contrasts in parts of machines are easier on the eyes than abrupt changes in brightness. Making the working area of the tool slightly lighter definitely tends to concentrate the attention on the work. A favorable contrast between machine color and color of the work highlights danger zones and so makes for greater safety. A three-dimensional effect is secured by controlled color contrasts; the work in machines so treated stands out in stereoscopic clearness that cannot be achieved with brightness contrasts alone or by increasing the amount of light on the work above a certain effective level.

As a result of the work so far accomplished in this new field of better seeing, several industrial plants have adopted the so-called "spotlight buff" and "horizon gray" for some or all of their machinery. It must be pointed out, however, that the "spotlight" color most effective for a certain job is not always buff; other colors will have to be called into play where the color of the material being worked on is not satisfactorily spotlighted by buff.

As was hinted in the first paragraph of this article, industrial machinery is not the only type of equipment that will be benefited by this research. In one of the du Pont plants where color charts are made, the gray and buff com-

bination has been applied to almost everything in various departments, even to the uniforms worn by the girls. Other combinations have been tried by the color-conscious management with results that they state are highly satisfactory.

Similar work is being done in offices. Ceilings, sidewalls, and dados are being painted in colors that depart radically from the conventional. Some of these combinations give not only better seeing by reflecting more diffused light to the working surfaces but, by proper color contrasts, give an impression of depth and spaciousness so valuable to the psychological attitude of the desk worker.

And the end is not yet in sight. As with most research work, early results are merely indicative of what is to come. Field investigations are being conducted with a view to amassing an array of data on which to build a more complete analysis of the entire problem. Enough has been accomplished, however, to establish the fact that suitable attention to color contrasts and brightness is essential if the best results are to be secured from any lighting system. And sufficient practical work has been done to indicate that this system of "three-dimensional seeing" can be applied to many plants and offices to result in increased safety, increased production, better working conditions, and improved labor relations.

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SORTER

For Metal Parts of Like Appearance

A SIMPLE device for "unscrambling" metal fittings used in lighting systems was recently assembled in one afternoon by C. S. Williams, of the Westinghouse Research Laboratories. The sorter was developed after a manufacturer of malleable cast-iron conduit fittings appealed to the Laboratories for apparatus that would sort out a mixture of tough and brittle conduit parts. All of the parts looked alike, but some had been heat treated and some had not. The untreated fittings were brittle and would break in service.

Four pieces of standard laboratory electrical apparatus and two small hollow coils of fine wire were used in making the device. One piece of apparatus was an oscilloscope, a device which makes electrical waves trace a visible path on a glass screen. When a fitting was inserted into one of the hollow coils, a green line on the oscilloscope screen told whether or not it had been heat treated.

The test was based on the balancing of magnetic fields in the two coils. When the tough, treated

Parts "unscrambler"

iron was placed in a coil of wire carrying an electric current, the magnetic field was increased more than when the brittle, untreated iron was tested.

All kinds of small steel or iron parts which have different effects on a magnetic field can be sorted by this method.

SCRAP SHORTAGE

A Problem in Steel Operations

ONE of the most difficult problems facing the steel industry in its effort to maintain production at peak levels for national defense and other needs is the threat of a serious shortage of steel scrap material.

Currently, the industry is consuming scrap at the annual rate of 42,000,000 tons. Actual consumption in the first half of 1941 was 40 percent above the same period in 1940.

The present prospect that the amount of scrap available will fall short of the total needed is causing deep concern in the steel industry and various companies are adopting unusual measures in an effort to obtain scrap. Some of them have appealed to employees and the public at large in the communities of plants for help in collecting supplies.

About 55 percent of the tonnage of scrap consumed by the steel industry is produced within the steel works through the cutting of ingots, blooms, and billets, cutting and shearing of rolled products and through other forms of accumulation of scrap material. The remainder of the industry's requirements is searched for and purchased in what is usually termed the open market.

The present threat of shortage reflects not only the record rate of consumption, but also the fact that the available supply has been lessened in recent years by large tonnages of scrap exported. From 1935 through 1940, 20,000,000 tons of scrap were shipped abroad, chiefly to Japan and Italy.

Steps to meet the situation include:

1. Consideration of plans by the government for a nationwide drive for the collection of light iron and steel scrap, similar to the recent widespread drive for aluminum.
2. Consideration of plans to locate remote resources of scrap, such as old automobiles, structural steel, old railroad cars, and other bulk supplies throughout the country, and make it economically practical to ship it to steel producing centers.
3. Urging British purchasing authorities to confine their purchase in the United States so far as possible to finished steel products, and to limit their purchase of semi-finished steel products.

Nine-tenths of the steel ingots produced in this country are made in open hearth furnaces. In the production process, scrap and pig iron are charged into the furnaces in the proportion of about half and half on the average, although the proportion varies widely among individual steel companies throughout the country.

This mixture of cold scrap and newly made pig iron is more quickly refined into steel than a 100 percent charge of pig iron. The saving in time arises from the fact that scrap steel already has been refined once, and therefore contains fewer impurities than pig iron.

When charged into the open hearth furnace, pig iron contains about four percent carbon. Usually, most of this carbon must be eliminated, since a large propor-

tion of all steels contains no more than one-fifth to one-half of one percent of carbon.

Scrap steel used in open hearth furnaces has most of its carbon and other impurities removed when originally manufactured. A mixture of scrap steel and iron is more quickly brought to the proper analysis than iron alone without the addition of scrap. Aside from the saving in time thus achieved, the use of scrap results in a saving of large quantities of coal which serves as fuel, and of limestone which is used as a purifying agent.—*Steel Facts.*

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TORTURE: More than 20,000 electric light bulbs are deliberately destroyed annually by lighting engineers in order to determine weaknesses in construction. The lamps are bumped, pounded, dropped, beaten, and burned out to exaggerate the worst treatment that they might receive in service.

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TIN-CAN 'CAMERA'

Photographs Location of Radioactive Atoms

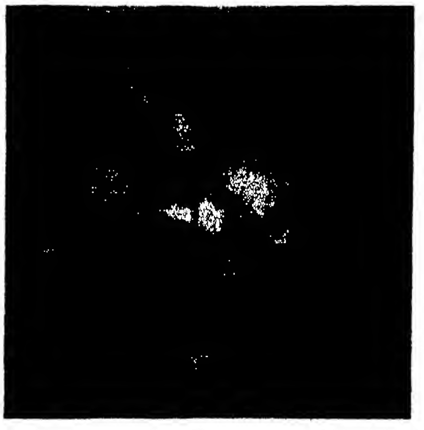
A PHYSICIST recently demonstrated how he used a tin can, two small brass disks, and a screw clamp to devise a simple "camera" that sees into steel with the aid of radioactive atoms.

Although it has no lens, shutter, or other parts usually regarded as essential on cameras, the tin-can device records on photographic film the rays from artificially radioactive atoms of phosphorus, thus revealing their location in the steel.

Dr. William E. Shoupp, who improvised this "camera" at the Westinghouse Research Laboratories to find out if phosphorus is well mixed with iron in steel, or if it is bunched together in spots, tells the story as follows:

"To study the problem, we melted a sample batch of steel into which we put radioactive atoms, or tracers, of phosphorus. The phosphorus had been made artificially radioactive by bombardment in an atom-smasher, so it would send out invisible rays like those emitted by radium. These rays do not affect the action of the phosphorus, but they reveal

Above: **Clamping film on both sides of steel disk.** *Below:* **Light areas indicate phosphorus**



the location of the atoms from which they are sent out.

"Then we molded a small disk of steel containing the tracer atoms. In a darkroom, we laid a piece of photographic film on each side of the steel disk, placed two small brass plates outside the film, clamped the stack of film together, and placed the whole thing in a tin can to keep out all light.

"The next morning we unclamped the 'camera' and developed the film, which then revealed light and dark blotches caused by the rays from the tracer atoms. Our problem was solved, because the light areas corresponded with little air pockets, or blow-holes, in the steel disk, showing the phosphorus had concentrated on the surfaces of these holes.

"We were interested in this subject because too much phosphorus makes steel brittle, and the more we can find out about the way these two substances combine with each other, the better prepared we shall be to improve steel-making."

Dr. Shoupp said this simple method of taking pictures of radioactive atoms could be used to reveal the location of other substances besides phosphorus. For example, steel also contains small amounts of sulfur, carbon, manganese, and silicon. Any of these substances can be made into tracers with the assistance of an atom-smasher.

STANDARDS

For Household Equipment To Conserve Materials

IN an endeavor to bring about important economies in production and distribution, and thereby mitigate the effects of shortages of strategic materials, the American Standards Association has been requested to proceed with standardization work upon household mechanical refrigerators, domestic washing machines, and electric flat irons.

Not only will such standardization have the desirable effects mentioned, but it also should result in better service to consumers and in a continuation of availability of equipment even though materials shortages became stringent. The standardization program involves a limitation on the number of models to be produced, a standard method of size rating to insure the greatest possible value to the ultimate consumer, a method of comparing effectiveness of units of different manufacture, and minimum performance and construction standards for the protection of the buying public.

HEATING COMFORT

Promoted by Use Of Unit Heaters

FACTORY employees in the new plant of the Charles Bruning Company are able to control heating both in accordance with the requirements of their own comfort and with the requirements of the work they are doing. In addition to the general heating system, the plant is furnished with large, circular, fan-type heaters, especially designed to diffuse heat in all directions. Thermostats are provided in connection with these fan heaters, so that employees in various sections of the plant may regulate temperature. The general heating system, of course, functions entirely automatically.

INDUSTRIAL TRENDS

MOTOR CARS AFTER THE WAR

Highly speculative today is the trend of the entire automotive industry, particularly the long-range trend reaching as far into the future as the end of the present emergency and the return, we hope, to normal industrial operation. At the time of writing, the motor-car manufacturers have completed their annual shift of models and are swinging into production of their allotted number of units, coincident with continued activity in producing or preparing to produce materials of war. Just what will be the final outcome of this many-sided operation by an industry that always has been geared to high-speed production of consumer goods in a highly competitive market?

Anyone who would try to give a definite answer to this question would also attempt to buck the pari-mutuels with hope of profit rather than for the pleasure of gambling. But there are certain known facts that can be considered and upon which may be based an estimate of the future, such estimate to be tagged "subject to change without notice."

First, the automobile manufacturers—nine of them—must be divided into the one privately owned company, Ford; the two "combines," General Motors and Chrysler; and the "independents," Hudson, Packard, Studebaker, and the rest. Then consider war orders. Most of these are being placed—to the tune of almost three billion dollars so far—on the basis of cost-plus contracts. In some cases the plus is as low as 5 percent, in others as high as 7 percent. OPM has indicated that the total orders placed so far will eventually be tripled.

Now the percentage of profit basis on which war orders are being taken is not too bad for some of the motor-car manufacturers, especially the independents. To some of these, at least, war orders may eventually prove more profitable than automobile production at the highly competitive prices that have prevailed for some time. To the combines and to Ford, however, the profits offered by government business are below those which they would realize under normal automobile business. Thus these profits will represent money in the bank for some and reduced earnings for others.

On the other hand, restriction of motor-car production is going to pile up a reserve of orders from new consumers and from those in the replacement field, so that by the end of the emergency there should be a substantial market for cars that were not bought for one reason or another during the period of curtailment. Add to this the fact that the automotive and aircraft manufacturing industries are being drawn closer together by wartime association, and the picture doesn't look too bad.

Then, too, motor-car manufacturers are learning many things by way of their participation in war goods production. They are learning that there are really no set rules for materials, that there are replacements or substitutes for things that were formerly considered irreplaceable. They are finding new ways of doing things faster, better, more economically. All of these factors are piling up in a bank of knowledge that can be drawn upon to the future benefit of all concerned. If good business management holds these companies together during the present period of stress, and if that bank of knowledge grows and is used, as there is every reason to believe it will, the trend of the industry in days to come should be toward a continuation of its activities as Number One among the industries of the United States.

WHAT ABOUT THE AIRLINES?

On this page in our October 1941 number was discussed the position of aircraft manufacturers in relationship to present conditions and to the future. Now let's look at another phase of the aviation industry, closely linked with manufacturing, yet with problems peculiar to its own field. This is the industry of getting passengers, mail, express, and freight from one point to another by the fastest means yet devised by man—air transportation.

Some months ago a feature article in Scientific American dealt with the predicament in which the airlines find themselves by reason of diversion of commercial planes to Great Britain and Russia. This was the dark side of the picture. While it still holds true—over 120 planes have been transferred so far—there is another angle of this national defense business that will undoubtedly benefit the airlines in the long run. Already its effects are to be seen. New planes, slowly being acquired by the airlines for replacement purposes, are larger, faster, as a result of lessons learned in plane construction through wartime requirements. For example, in some cases transports carrying about 10 passengers are being replaced by ships with a capacity for 24. In this manner the airlines are able, to some extent, to meet the increasing demands for service, largely engendered by national defense programs and their call for more and faster transportation.

This is the sort of thing that will redound to the benefit of the airlines, and may be considered as a reliable guide to the future trend of the industry. Military planes capable of carrying huge loads for great distances are being built and put through grueling tests. From these ships will be spawned the transport planes of the future, planes that will serve the traveling public with air transportation on a scale never before seen.

FOOD PROTECTION

Hard hit, among others, by the diversion of aluminum from consumer fields to national defense requirements is the packaging industry, large users of aluminum foil for wrapping many commodities offered to the public, notably food. Now, however, comes the Reynolds Metals Company with a product of research that, it is claimed, is an ideal substitute for aluminum foil. Made of an alloy of lead and tin, the new foil opens the way for a trend in the packaging industry, being opaque, impervious to moisture, and reflecting about 95 percent of the radiant heat that strikes it. With these characteristics, it protects foods against many of the factors that can cause spoilage and other changes.

—*The Editors*

Who Threw Them?

Dunninger Plays the Role of Poltergeist

By Dexterous Digital Manipulation

A. D. RATHBONE, IV

Secretary, Scientific American Committee for the Investigation of Psychic Phenomena

So far as I know or have been able to find out, no one ever *sees* a poltergeist. One merely suffers varying degrees of annoyance from its prankish, often childish, antics. In "An Encyclopedia of Occultism," by Lewis Spence, poltergeist is defined as: "The name given to the supposed supernatural causes of outbreaks of rappings, inexplicable noises, and similar disturbances, which from time to time have mystified men of science as well as the general public. The term poltergeist (*i.e., Polter Geist, rattling ghost*) is sufficiently indicative of the character of these beings, whose manifestations are, at the best, puerile and purposeless tricks, and who not infrequently display an openly mischievous and destructive tendency."

From correspondence I have had with Mr. Harry Park, of Los Angeles, California, since last spring, it might be said that he is troubled with a poltergeist. Park, a man 71 years of age, runs a tiny printing establishment (the Clipper Printery) within a 15-foot-square ground floor space in the downtown section of that western metropolis. About half way up to the 12-foot ceiling is a miniature balcony, reached by a short flight of stairs. On the balcony are located a washroom and storage space. All windows are adequately barred, and there is positively no entrance, according to Mr. Park's letters, other than the front door. "The ceilings and floors are perfect," he wrote, "and we have offered five dollars to anyone who can find a hole big enough to push a marble through, to say nothing of throwing with considerable force articles three-by-three inches." During a period of two years both Park and his wife—who also works in the printery—have been pestered by having a total of over 200 articles thrown at them, apparently from nowhere, apparently by the hand of no living person. Many witnesses have observed these manifestations, and I have in my files the signed statements of several.

Whatever it is that motivates the pitching of the various articles about the shop isn't particular what it throws. In my possession are a number of bent nails, a dozen twisted, wire paper clips, several leads and slugs from type fonts (which I have been informed do not tally in size or style with any in the Park printery), a couple of small pieces of old, brown linoleum, a U-shaped piece of wire, an agate marble, and a machine nut, measuring three-quarters of an inch square, which, if it hit anybody on the head could cause an unpleasant bruise. All these and scores of additional articles have been thrown at one time or another during the past two years by this unseen force, most of them while witnesses were present.

● The experience related in the accompanying article is not to be construed as part of the official proceedings of The Scientific American Committee for the Investigation of Psychic Phenomena. Although in no way concerning the Committee as a whole or the publishers of Scientific American, we believe the episode described to be of sufficient interest to warrant publication.—*Ed.* ●

Recently a man, whose name must be withheld, came to see me and stated he, too, had seen these amazing incidents occur. He had heard of the peculiar phenomena that were taking place at the Clipper Printery, and had visited Mr. Park a number of times, purely out of curiosity. Never had he been in the shop that something had not been thrown. My visitor brought me a manila envelope which contained the bent nails, paper clips, bits of linoleum, and the other mementos I have described. He stated he had seen several of these things land on the floor, on the type cases, on a table. At other times he had heard them land and had turned around to find they had struck the floor behind him.

At this point in my narrative it is imperative to note that thus far in the Park case no one connected with it is or has been associated with any phase of spiritualism. No one, not even Mr. or Mrs. Park, claims to be clairvoyant, psychic, or to possess any occult or supernatural powers. (In available histories of poltergeists, this situation is not unusual.) According to witnesses with whom I have discussed this case, however, the proprietor of the Clipper Printery can, more often than not, apparently cause the phenomena to recur. The witnesses have stated that sometimes an article will be thrown, that it will fall behind a piece of heavy furniture where it cannot easily be retrieved or seen. Under such conditions Mr. Park will say: "Please, Mr. Ghost, will you do that again? We couldn't see it that time." Within a moment or so, the performance is more often than not repeated.

When my necessarily anonymous visitor walked into my office with the avowed intention of presenting the facts of the matter as he had seen them with his own eyes, he graphically described his calls at the print shop and what he had seen. He was an enthusiastic man of 30-odd years, with that typical New England faculty for keeping both feet on the ground, and of scanning new acquaintances and new experiences with customary meticulous shrewdness and carefulness; not a man to let his imagination run away with him, but quite evidently what he had seen in the little Los Angeles print shop had impressed him to the core. As the whole thing was patently of sufficient interest to warrant it, I made an appointment with Dunninger, Chairman of the Scientific American Committee for the Investigation of Psychic Phenomena.

Arrived at Dunninger's apartment, I introduced the two men and we took seats. Dunninger, a big fellow, well built, threw himself carelessly down on the davenport, his arms stretched out along the back in complete relaxation. My companion chose a straight backed chair, while I slouched into an easy chair by a window where

I could observe both of them, and remarked: "Well, it's your story. Tell Dunninger what you told me."

In the course of his narrative, our friend arose, approached to within five feet of Dunninger so that both were in my direct line of vision. With exceeding emphasis and with his eyes intently on Dunninger, our visitor told about the amazement he had experienced when first a paper clip had fallen on the floor behind him at the Clipper Printery. There had been no one in back of him, he said, and he had neither seen nor sensed any movement on the part of either Mr. or Mrs. Park. He paused a moment to catch his breath, and in that instant of quiet, something hit the floor behind me with a minute clicking sound. I had been watching Dunninger's expression closely to obtain his reaction to this story of mysterious happenings and I could have sworn that he had not moved a muscle—but something had hit the floor behind my chair, and it sounded for all the world like a paper clip!

I know I opened my mouth, and I glanced at our visitor. His mouth was open, too—farther than mine, I'll wager. Our surprise must have been only too evident, for Dunninger laughed and said: "Don't bother to look for it, Rathbone. You won't find it."

Now I know Dunninger fairly well. I have seen his sleight-of-hand performances, his exhibitions of the magician's art, several times, so the first things I looked at were his hands and his arms. They still were completely relaxed along the top of the davenport, one on either side of him. Then I looked at our visitor and really was alarmed, for his face was as white as chalk. He was unsteady on his feet and there was a look of utter disbelief on his face such as I have never before seen on any man.

"Why!" he exclaimed, almost breathless with astonishment, "It's followed me here! That's exactly the same thing I saw at Park's!"

"You don't think *I* caused that, do you?" asked Dunninger.

"Why, no. You couldn't have. You didn't move. I was looking right at you."

"Did you see me move, Rathbone?" questioned the magician.

I shook my head, but I was extremely suspicious. I had seen Dunninger exhibit his digital dexterity many times.

Then an astounding thing happened. Now on my guard, I was watching Dunninger's hands most intently, and although there was no apparent motion, I saw something flash through the air and fall to the floor directly in front of our visitor. He saw it, too, and we both looked near his feet where it had landed. It was a pair of tiny tweezers.

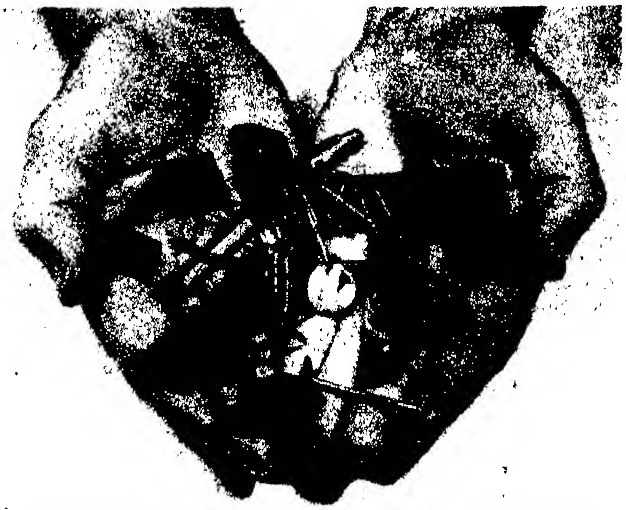
"You—you've done it!" he gasped.

"Done what?" queried Dunninger.

"Just what the ghost, or whatever, did to Mr. Park. But I didn't see you move," he added, doubt still pre-eminent in his voice.

Dunninger laughed, and, "Of course you didn't see me move. Why should you expect to observe movement? Now watch me closely. I'll do it again," and with that the small cover of a medicinal container landed on the floor between us, but again, I saw no movement of the magician's hands or fingers. It was the old story—the hand is quicker than the eye—plus a disarming and diverting personality and conversation.

But all the candor and pleasantries in the world weren't going to fetch our guest back to normal in an instant. He had visibly been too greatly affected. He had the appearance of a man who had come to tell us about a momentous incident, only to find that the incident had been duplicated at will before his eyes—and he couldn't make up his mind whether to believe that what he had previously seen had been a hoax, or that the poltergeist had followed him from California to New York. His dismay and perturbation were so pathetic that Dunninger took pity on him and explained that he had performed a sleight-of-hand trick, that there was nothing supernatural about the episode, and that there was nothing to fear.



Were these the weapons of a poltergeistic attack?

Dunninger talked soothingly to our disturbed guest, and while he was discussing what had proved to be not a spiritistic demonstration, but merely a legerdemainic performance, the following items dropped, apparently of their own accord, and equally apparently from nowhere at all: another paper clip, a tiny nail, and a small stove-bolt nut.

During the entire time these odds and ends were dropping promiscuously in this or that part of the room, I only once saw a very slight movement of one of Dunninger's hands. It was so imperceptible that our befuddled guest missed it, but it was there and coincidentally I saw a paper clip fly through the air.

Now let me make one thing clear. I have never visited the Clipper Printery. I have not with my own eyes seen the things described to me by word of mouth and in detailed written form that are reported to have taken place in Harry Park's 15-foot-square printing establishment in Los Angeles. The evidence presented makes me believe they have happened and continue to happen, and I have no idea what causes these apparent phenomena. But I do know that when, for the first time, the performance of Park's "poltergeist" was described to Dunninger, he duplicated the exhibition to such perfection as to all but knock a hard-headed Yankee off his feet. And I can take oath that only once —just for a tiny instant—during his entire demonstration did I see his fingers or his hands move from their relaxed position on the back of the davenport. How it was done, I do not know—and magicians are not generally noted for being loquacious concerning the modus operandi which they employ. Confidentially, it was beyond my powers of observation—but then, perhaps Dunninger, too, is obsessed with a poltergeist!

93,000,000 Miles

After a Decade of Laborious Calculations, the Sun's Distance is Slightly Corrected

HENRY NORRIS RUSSELL, Ph.D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of Carnegie Institution of Washington

THERE is an old saying that we do not understand a thing well until we can measure it. This obviously does not apply to everything—for example, the intensity of a toothache—nor would it be fair to claim that we understood something twice as well because we had learned to measure it with half the previous uncertainty. Precise measurement has led to many wholly unexpected discoveries—from that of Neptune to that of argon. But the chance of such good fortune is not the motive of the investigators who are still seeking to make our measures more accurate. Like true devotees of science, they do it for fun—they toil for months or even years in devising and applying methods of precision — as others rejoice in finding a new and more direct route to climb some beetling mountain peak. This challenge is peculiarly tempting when there is a weak link in a chain of related measurements. For example, the shapes of the orbits of the planets, their relative sizes, and the laws of motion of the planets along their orbits, can be determined with great precision.

In terms of the Earth's mean distance from the Sun—the "astronomical unit"—the dimensions of its orbit, and of those of the inner planets, can be found with an accuracy of about one part in a million, and comparable accuracy can be reached for Uranus, Neptune, and Pluto, when they have been observed over a sufficient number of revolutions.

We have specifications for a map of the solar system, incomparably more accurate than any drawing could possibly be made. But this map has no scale of miles.

To put one on it, we must first find the dimension of the Earth in miles—which has been done, by the combination of accurate surveys of large parts of its surface, with a precision of one part in 50,000. It will then suffice to find the distance of any planet at any time, in terms of the Earth's radius; for the relation of this distance to the astronomical unit can be calculated with great accuracy.

In principle, we have only to sight on the planet from two widely separated points on the Earth at the same time, and the intersection of the two lines of sight locates it. No single pair of observations can give a precise result, for the planet's distance is always thousands of times the Earth's diameter, and a very small error in determining the convergence of the two lines of sight will produce a serious one in the calculated distance.

BUT if we have found, in this way or any other, an approximate value, we may proceed to derive a very much more accurate one, by combining all the available observations — perhaps hundreds of them, made at many observatories.

If the planet's orbit is well known, the direction can be calculated in which the planet would appear at any given time as seen from the center of the Earth—or, more realistically, by an observer on the surface in line with the center and the planet. At this moment, observers elsewhere on the Earth will see the planet in different directions. This shift from the geocentric position—the parallax—is different for each observer, and changes as each one is carried around by the Earth's rotation. But its amount and direction can be calculated, for any place and time, by simple geometry, except for a scale factor to which it is proportional. This factor represents the radius of the Earth, in seconds of arc, as seen by an observer at the standard distance of one astronomical unit (or on the Sun at its average distance), and is called the solar parallax.

With our approximate value of this, we can calculate where the planet should have appeared among the stars each time it was observed. If our approximate values happened to be exactly right, if the elements used in calculating the planet's motion were entirely correct, and the observations free from error, these calculated positions would all agree perfectly with the observations. Of course, this will not happen in our imperfect world — there will be small outstanding discordances, or "residuals" for each observation — representing the combined effects of errors in the adopted values of the solar parallax, of the elements of the orbit, and of each individual observation.

TO separate these influences might seem hopeless; but if we have observations enough, made according to a properly planned program, it can be done. A correction to the assumed value of the solar parallax will affect each observation by an accurately calculable multiple of its own amount. The same is true for corrections to the orbital elements. From each observation we thus get an equation connecting the values of these corrections with the residual. All told, we may have hundreds of such equations, from which to find the values of half-a-dozen corrections. We cannot satisfy the equations exactly, for the errors of observation are still in them. But we can find a set of values of the corrections such that the outstanding residuals, after they have been applied, are as small as possible. Some of these residuals will be positive and some negative; so the rule is to take their squares, which are of course all positive, and reduce the sum of these to a minimum. When the algebra is carried through, it turns out that this "method of least squares" gives a definite answer to the complicated problem. If we know that some sets of observations are more accurate than others, this can be, and is, allowed for in making the solution.

The reader may have suspected that this process is laborious. It most certainly is; but it gives us results which represent the observations as well as can be done. These results will not be perfectly accurate; the errors in the obser-

vations will creep into them and produce small errors in the final values. These may make our calculated results too large or too small. We do not know which; but we can estimate the chance that this unavoidable error lies within certain limits.

From the final residuals we can find the "mean-square" discordance of an observation, and from this we can calculate the "probable error" of our final value of the parallax—that is, a quantity such that it is an even chance that the actual error is greater. The probability of large errors falls off rapidly. There is about one chance in six that an error is more than twice, and only one in 23 that it is three times, the probable error.

We can thus get a good idea of the trustworthiness of our results, provided that our observations have not been infested with the worst enemies of precise measurement—systematic errors. These are errors which repeat themselves every time that observations are made in the same way. The errors that may arise from sources which are understood—such as refraction—are of course carefully allowed for in working up the observations, or the program itself may be designed so that they are avoided or averaged out. Errors of unknown origin can be detected only by comparison with observations made with other instruments or by other methods. Some, but not all of them, can thus be detected and cleared out during the progress of a major piece of work.

So far, nothing has been said about the main question—which planet to observe. The asteroids, which appear on photographs as sharp, star-like images, are far preferable to the larger planets. Among these, the best to observe are obviously those which come nearest the Earth, and at times have large parallaxes. As soon as Eros was discovered in 1898, it was realized that it surpassed all other planets for this purpose. Its orbit, at perihelion, passes within 14,000,000 miles of the Earth's. It is very rarely that the two planets happen to come to the proper point at the same time. In 1901 they approached within a little less than 30,000,000 miles of one another, and extensive series of observations for parallax were made at many observatories. No better opportunity occurred till the winter of 1930-31, when Eros came within 16,200,000 miles of the Earth. No equally favorable approach will occur for a long time to come, and the planet was extensively observed.

In recent years, two or three tiny asteroids have been discovered which, at times, can come much nearer to the Earth than Eros ever does; but it is doubtful whether they will be more valuable for the determination of the solar parallax. To begin with, these very near approaches depend upon an even closer coincidence of the time of passage of the Earth and the planet through the right points on their orbits, so that they will be very rare. Just because the approach is so close, the planet stays near the Earth for only a few days, while Eros can be followed for months. Finally, the smaller bodies are so faint that, even when close, they can be photographed only with powerful instruments, while Eros, under such circumstances, is of about the same apparent magnitude as the stars which are used as reference points on the photographs, and good images can be obtained with short exposures.

The general discussion of the observations of Eros in 1931 was placed by general agreement in the hands of Dr. H. Spencer Jones—Astronomer Royal at Greenwich—who had proved his skill, thoroughness, and good judgment in handling masses of observations in several important investigations. The first announcement of the results was made to the Royal Astronomical Society last June — ten years after the observations were completed. For this apparently long delay, the War has at most a minor responsibility. The main reason is the great extent and laboriousness of the calculations. Part of this may be understood from the summary account given above; but this says nothing about the most time-consuming part of the work—the detailed reduction of every plate, or of each visual observation. Before this could be done, the positions of the reference stars had to be known. A long list had been carefully observed with meridian circles at various observatories, but to supplement it the places of nearly 6000 fainter stars were measured photographically—as a part of the work which was merely preliminary to the main investigation!

Other lengthy calculations were made to find the systematic errors peculiar to different instruments, the corrections due to peculiar conditions on individual nights, and the relative accuracy of the different series of observations. It was finally found possible to combine the observations with 16 different instruments into a single consistent mean value. For the solar parallax, this came out 8″.7900 ± 0″.0013. As appears from the probable error, the last figure is not significant—it is given to avoid error due to neglected decimals in the use of this value in future work. But it appears to be ten to one that the actual parallax is somewhere between the figures 8″.793 and 8″.787.

The results obtained from different methods of observation (visual and photographic), from right ascensions and declinations separately, and from observations with different instruments and at different places, are remarkably accordant — the extreme outside range given by them being from 8″.788 to 8″.791.

The finally adopted value corresponds to a mean distance of the Sun of 93,010,000 miles, with a probable error of 15,000 miles. The round number 93 million miles may be adopted for all purposes. This makes the Sun's diameter 865,400 miles, and its mass 333,400 times that of the Earth.

These values of the distance and diameter are greater by 0.15 percent than those which have previously been adopted, as the new value of the parallax is less in the same proportion. The new value of the mass is 0.45 percent greater, as it involves the cube of the parallax.

This change is rather larger than would have been expected. But the new set of observations, judged by the agreement of the different instruments, and so on, should be many times more accurate than the old, and there is every reason why it should be generally adopted. It seems probable that the older value, which depended largely upon the observations of Eros under less favorable conditions in 1901, was affected by some small, and effectively concealed, systematic error. But more work, as is usually the case, will be necessary before this question can be finally settled.—*Princeton University Observatory, October 2, 1941.*

Insulating "Blackout" Plants

Windowless Bomber Factories Will Contain More Glass Than "Daylight" Structures

H. T. RUTLEDGE

A NEW type of shatter-proof, non-combustible side wall and roof construction, combining three types of glass fiber with pre-fabricated steel panels, is being used to insure insulation and acoustical control for working efficiency in the twin 4000-foot-long Army bomber assembly plants being erected at Fort Worth, Texas, and Tulsa, Oklahoma.

Engineers of The Austin Company, who designed both plants, evolved the ingenious combination which utilizes products developed by Truscon Steel Company and Owens-Corning Fiberglas Corporation in a new approach to the task of insulating vast factory areas for economical year-'round air-conditioning. The plants are so large, however, that, even with this efficient type of construction, each requires 7000 tons of refrigeration—enough to operate more than a quarter million large household refrigerators—to insure year-'round working comfort and production efficiency in the two plants, where a total of 30,000 men soon will be assembling four-engined bombers on moving assembly lines.

With a total of 406 carloads of fiberglas required for these jobs—203 carloads for each plant—the buildings will probably contain more glass in their windowless steel side walls and roofs than the largest daylight factories ever built. Alternate layers of fiberglas and special vapor-seal paper, held together with asphalt, are being combined with steel channels, roofing sections, and metal lath to give the walls and roofs of all buildings maximum strength and the highest obtainable acoustical, insulating, and light-reflecting qualities.

Both plants are being built for the War Department under direction of the United States Corps of Engineers, who have a staff of 30 engineers and 238 inspectors, auditors, and clerks on the job at Fort Worth. The Austin Company has its own staff of 102 engineers and 20 clerks at work on plans, specifications, and the detailing of mechanical equipment and production layouts for the two plants in a downtown office building there, where Consolidated Aircraft Company, which will operate the Fort Worth plant, has its own consulting engineer. They all work seven days and three evenings a week, or a total of 65 hours.

ANOTHER group of 147 engineers, superintendents, auditors, purchasing agents, and clerks are located in field offices on the 1450-acre bomber plant site overlooking Lake Worth, where 3500 construction workers are building the plant on a two-shift schedule that runs from 5 A.M. to midnight, seven days a week. This crew will soon reach 6000.

Manhattan-Long Construction Company, general contractors for the Tulsa plant, which will be operated by Douglas Aircraft Company, is using nearly a million dollars' worth of construction equipment, ranging from huge graders, trucks, cement mixers, hoists, and erecting cranes to wheelbarrows and small hand tools on the work at Tulsa. There is about the same amount on the ground at Fort Worth.

The 27,000 tons of structural steel required for each plant was more than any single steel mill or fabricating shop could deliver in the limited time allowed. The Bethlehem Steel Corporation has been able to meet the required schedule on steel for Fort Worth, however, by distributing this work among seven of its plants at different locations. Several companies have co-operated in production of the steel for Tulsa, which is being fabricated under a contract with the Midland Structural Steel Company of Chicago, in 17 shops throughout the Mississippi Valley and the Southwest.

Because all of the 171 200-foot trusses required for the main aisle of each plant are 25 feet deep and an equal number of 120-foot trusses for the side aisle are 16 feet deep—all too high for shipment of any completed segments by rail—they are being assembled entirely on the site. While these spans weigh 40 tons and 25 tons respectively and can be assembled on the ground and raised into place in one piece, 115-ton jack trusses of 200-foot span are being assembled in place with the aid of heavy false-work.

Only one 200-foot hangar door opening has been provided in each

Assembling a leaf of a vertical-lift door of the type to be used in the twin bomber plants described. These units will be insulated, weatherproofed

plant, that being at the end of the assembly line. These doors, and eight 200-foot doors in the nearby hangar building, will be of the Truscon vertical lift type, installed in 100-foot-wide units to operate independently of each other. Four 150-foot single-unit doors of the same type will be used in the paint shop. All will be 40 feet high and insulated in a manner comparable with the side walls, with weatherproofing at jambs in keeping with the requirements of air-conditioned buildings.

The assembly buildings and a majority of the auxiliary structures at each plant have an overall height of 65 feet. A 13-inch curtain wall of face brick and acoustic block, which is being specially reinforced with trussed rods to make it shatter-proof, rises to a height of 12 feet around the base of all buildings. The special insulated metal wall extends from that point to the roof. Fiberglas insulation board continues right down to the base of all walls through the masonry in order to insure absolute control of moisture condensation. Even the bolts used to anchor the upper walls are being insulated to prevent any continuous steel contact between exterior and interior.

The roof and wall construction will be uniform in all buildings at each site, including a two-story office building, a maintenance shop, and boiler house, all of which adjoin the 4000-foot-long assembly building, and a paint shop, hangar, and cafeteria buildings, which are separate structures.

Bomber assembly plant at Fort Worth under construction, with 11,000 tons of the ultimate 27,000 tons of structural-steel framework in place

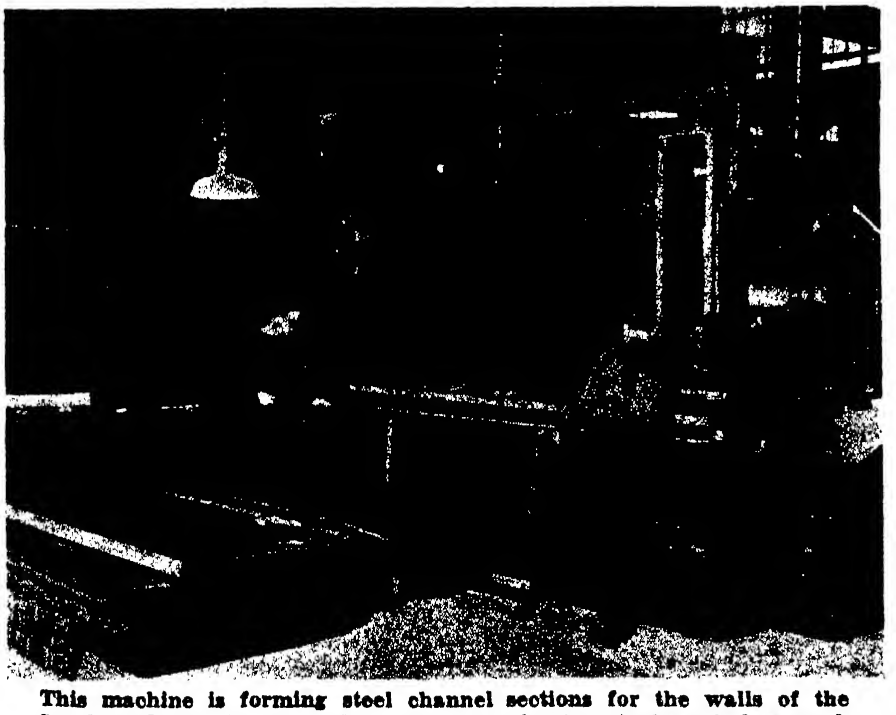
By blanketing the interior walls of each structure with white fiberglas, the engineers have not only provided for insulation and absorption of between 60 and 75 percent of all factory and office noises, but have also obtained a light-reflecting surface which will maintain brightness at a high level. Each assembly building will have 17,000 two-tube 200-watt fluorescent units recently developed by General Electric Company for high bays, to provide at least 35 foot-candles at the working plane in continuous service. A white cement floor will enhance the general lighting efficiency by reflecting light up to the underside of parts and planes on the assembly lines.

Each plant has been designed with two mezzanine levels alongside the assembly line, for storage of various parts and sub-assemblies convenient to the particular assembly station where they will be needed. These mezzanines are suspended from the 120-foot trusses spanning a secondary aisle beside the 200-foot-wide assembly aisle, and are supported on one side by the center columns.

It was necessary to provide some passage for monorails from aisle to aisle at intervals along the assembly line, and this need has been met by limiting the length of mezzanines to 450 feet so that there are seven 50-foot transfer aisles available for monorail crane connections. This has resulted in the creation of eight separate mezzanines at each level, 30 feet by 450 feet, and these are served by eight rotary lift hydraulic elevators large enough to handle all but the heaviest parts and bulkiest sub-assemblies, as they are received by truck or rail from automotive factories, engine manufacturers, or other plants participating in the bomber-building program.

With food wagons and first-aid stations, tool cribs, washrooms, and toilets all located directly below the mezzanines or on them, nothing will obstruct the free operation of the interconnecting monorail systems which will serve the entire area of each assembly building. They will be capable of carrying a fully assembled four-engine bomber the entire length of the 4000-foot assembly aisle where 40-foot clearance has been maintained, or transferring other overhead loads up to 20 tons between any two points in the 1,294,000-square-foot building area.

Bombers will progress through the final stages of assembly on parallel conveyors extending nearly 2000 feet through the buildings.



This machine is forming steel channel sections for the walls of the bomber plants, the channels to be filled with four inches of glass wool. Interior wall surfaces will be faced with white dust-resisting fiberglas

Just What is Insanity?

Essentially it is Simply a Lack of Proper Adjustment to Environment and Society

L. J. PANKOW, M.D., B.M., B.S.

INSANITY has been defined as a prolonged departure from the individual's normal reactions of living, thinking, and acting, and has also been called the result of a failure of adjustment of the individual to his environment. The environment is the situation in which the patient is found, which obviously differs with times and places. How the individual meets various demands and adjusts, or fails to adjust to them, determines what is called his sanity or insanity. This adjustment is a gradual affair from infancy to old age, the young child having few adjustment problems and the mature person having many.

The unborn child has no conscious wants. The instant he is born, however, he begins to have to do some things for himself, instinctively starting to breathe and nurse. But still, the problems are very minor, and very little adjustment is demanded. As the child grows older, he must ask for a drink of water when he feels something that experience has taught him is thirst, or for food when he feels something that experience tells him is hunger. The mind at this time works in a thirsty-drink and a hungry-eat manner. Still later, the individual finds that the idea changes to a hunger-work-money-purchase-prepare-eat idea. It is the matter of how well the individual responds and adjusts to these desire-effort-satisfaction demands of society that determines his normalcy.

There are certain desires that cannot be gratified, and it is the reaction of the individual to the thwarted desire that determines the normalcy of the individual. In any person the reaction to a thwarted desire will be one of three things: He will forget it entirely; substitute something else for that desire; or enter into a little world of his own, becoming obsessed with the idea that he *has* satisfied that desire. Adjustment, either by ignoring or forgetting, or by a substitute desire, is normalcy; and inability to adjust to the disappointment of one's environment, the abnormal or insane. Practically every case of insanity will be found to have some basis of similarity to this formula. Whether it be due to injury, toxin, drug, disease, degeneration or congenital weakness, it is an inability to cope with the environmental situation that constitutes insanity.

Originally published in *The Journal-Lancet*, Minneapolis, Minnesota, under the title, "What the General Practitioner Should Know about Insanity." The author, with a medical degree from the University of Minnesota, is a Sioux Falls, South Dakota, general practitioner who served on his county insanity board for 15 years, and the article is based on his studies and experiences during that time.

EVERYONE suffers disappointments and experiences thwarted desires. What elements, then, determine whether one shall be able to cope with these disappointments satisfactorily, or develop an insanity? Two elements enter into this determination; the predisposing and the exciting factors. Predisposing factors are chiefly heredity and such elements as the different epochs of life, such as puberty, marriage, involution, and senility. One might compare a person to a piece of wood to be carved by a whittler's knife. Some woods are naturally soft and respond well to carving. Others are normally hard to carve, but when softened by some process, lend themselves well to carving. Heredity determines what type of wood the individual is, and the physiological epochs of life may constitute a softening treatment that renders the hard wood more easy prey upon which the exciting causes work.

The actual exciting causes for insanity may be either physical or mental insults to the system. Physical insults are such things as toxins or poisons, which may arise from within the body or from ingested drugs or poisons. Other physical insults include injuries and diseases. Mental insults are such things as sudden severe problems. Heredity does not, in itself, have as great an influence on the production of an insanity in a given individual as might be supposed, nor as great as has been formerly believed. True, an heredity well sprinkled with insanity is more apt to produce an individual who is more easily unbalanced in an attempted adjustment to life and the environment, but this is not necessarily so. It is enough to say that certain hereditary characteristics and predisposing weaknesses may make the individual sufficiently impressionable so that social and environmental adjustments are too hard to make, and insanity results. Also, unless there *are* some predisposing weaknesses of the mentality due to heredity or some other weakness, few of the exciting causes alone are sufficiently strong or damaging to produce an insanity.

All symptoms of insanity are due to a derangement of the normal psychic or thinking reflex action. A reflex is the reception of a stimulus, the handling of that stimulus in the central nervous system, and resultant action. A reflex action may be either mental or physical. A simple physical reflex action is the knee jerk. A mental reflex is similar except that the stimulation, whatever it be, is carried up to a higher level of the nervous system, the consciousness, where the mental reaction results in a definite thought or action. Normally, this thought or action will always be the same in the same individual from the same stimulation. It is other accompanying stimulations that enter with it that appear to give varied reactions. When, however, a derangement of the mental faculties exists, odd mental reactions develop from these stimulations. Such disordered thought-actions and thought-reactions produce symptoms of insanity.

DISORDERS of perception mean there is some fault in the *reception* of a stimulus. These constitute the various types of illusions and hallucinations. An illusion is an improper interpretation of an actually seen object. An hallucination is the reception of a stimulus that never occurred. For the pur-

pose of this discussion, illusions will be separated from hallucinations only from a point of academic interest, and hereafter both phenomena will be considered as hallucinations. Hallucinations are of different forms, referable to and classified by their origin from one of the senses. Thus, auditory hallucinations are voices or sounds heard by the patient when, in fact, no sounds were actually made. Visual hallucinations consist of seeing things that did not exist in fact. Hallucinations of smell, taste, and feeling give rise to their respective false beliefs of the patient.

The dream states border very nearly on true hallucinations in that one imagines seeing, hearing, and perceiving things that do not exist. Clouding of the consciousness is also a form of hallucination, because, whether it be a mild clouding or a deep coma, the condition is an improper perception of the environment. Also in this class of improper perception is disorientation, whether it be disorientation of person, disorientation of time, or spatial disorientation. Hallucinations in general are the appearance to the individual of something which he has successfully repressed or covered up prior to a weakening of his consciousness. They may represent sexual desires, or the covering up of an inferiority by clothing himself in power. They may be either pleasant or unpleasant, and their true meaning is found only in psychoanalysis. The psychopathic dream states, disorientations, and cloudings of consciousness, are all very probably mild hallucinations, and probably represent the exclusion of or getting away from some unpleasant or intolerable situation or circumstance.

HALLUCINATIONS are disorders of ideas due to a faulty perception. There are other disorders of the content of thought due to stimulation, arising from within the mind itself. These are such things as delusions, fixed ideas, obsessions, and the like. False beliefs need not necessarily be delusions, but perfectly normal deductions from false bases. Examples of false beliefs which are not hallucinations are such things as believing it to be a Monday because the washing is seen on the line. So, again, the difference between a false idea and a true delusion is that there are supporting facts to prove the false idea, while a delusion needs no supporting facts whatever. A delusion may be fixed or changeable, systematized or unsystematized. A fixed delusion is one that the patient adheres to constantly, while the changeable delusion is rapidly and quickly replaced by others. A systematized delusion is one in which the individual believes something false, not supported by any facts, and as a result of which he acts, coloring his life by his delusion. Delusions, too, are frequently defense reactions to avoid unpleasantness. Fixed ideas and obsessions are mild delusions, and may be found in otherwise perfectly normal persons, as well as in the insane. A fixed idea is one firmly planted on the consciousness, which may or may not be entirely erroneous. The thing that makes it a fixed idea is the fact that the person governs his life by the idea.

An obsession is frequently accepted as and known to be false, and yet the subject is unable to act uninfluenced by his obsession. With an obsession, a person cannot rest until he has yielded to it, after which time he is comfortable and satisfied. Phobias are forms of obsessions that are pathological. Common ones are the fears, or phobias, of being in a narrow closed place, being in crowds, being alone, and so on. In themselves, the phobias are not very important symptoms, but when associated with others, they may indicate a failure of adjustment.

THESE disorders of perception, called various forms of hallucinations, and the disorders of thought content, called delusions, are single thought disorders. They may start a chain or train of thought, it is true, but in themselves, they are really single, individual, and more or less isolated thought entities. They may color the train of thoughts, but in themselves do not alter the *course* of thinking. Normal thinking progresses in a direct line to a definite goal. Even a person suffering from hallucinations and delusions may have a normal *process* of thinking. Normal thought, then, progresses toward a definite goal and all other thoughts and ideas fall into a proper position until the goal is attained. One disorder of the train of thought is called flight of ideas. In flight of ideas, there is no goal at all, or, if there ever was one, the train never arrives. The ideas are connected phonetically, or in the mind of the patient. Some sound of a word used in a statement he makes will remind him of another thing, and he jumps to a statement about that. The disconnected thought is as apt to be used as the connected. It is due to the extreme distractibility of the patient that this is so. Frequently an idea from outside the mind of the patient may distract him.

Circumstantiality appears similar to flight of ideas, but differs in the very important detail that the patient will eventually arrive at his goal. There is a definite relationship between the thoughts stated, but the patient is unable to differentiate between the important primary ideas and the secondary ideas, and so includes them all.

RETARDATION of the train of thought, or difficulty of thinking, is a limitation of the patient's stock of ideas. He will, if given enough time and encouragement, eventually arrive at the goal. More severe retardation is a complete paralysis of thinking, a total loss of all thought. If there be any response to a question or command at all, it may be nothing more than a repetition of the words just spoken to him.

These phenomena usually have a meaning. In the flight of ideas and the circumstantiality, the patient has some idea which he wants to hide. In the retardation and paralysis, the defense mechanism has failed, and the subject retreats into slowness or silence.

Disorders of feeling are also disorders of the thought content, but of those special thoughts called emotions. Exaltation is a feeling of elation not warranted by the environment. Depression is an unwarranted unhappiness, dejection, or melancholia. There may be a total loss or severe impairment of emotional feeling. Severe emotional impairment is usually found only in greatly deteriorated minds. Morbid anger, also an emotional instability, is found especially in the feeble-minded or mental defectives with mental deterioration. This condition is an insanity or psychosis superimposed on a feeble-mindedness. These patients frequently go about looking for something to get angry about. When encountered in one of the less feeble-minded, it becomes a very dangerous condition, for the patient is capable of some sustained

thought and can lay plans for revenge. The excessive emotional expression is usually a matter of the person getting into the emotional state that his various hallucinations and delusions may have placed him, or where he feels he deserved to be. Absence of the emotions usually denotes that the patient is living in his imagination entirely, where he is apart from everything else, and enjoying himself with no help from the world at all.

Amnesias or memory losses, which are severe forms of ordinary forgetfulness from which we all suffer to some extent, may be due to some toxic or traumatic injury to the brain structure itself. In such cases they are hardly symptoms of insanity. When not due to some insult to the brain tissue, however, they are usually an expression on the part of the person to forget some unpleasant experience. Paramnesias, or remembering things that never happened, are just the opposite of forgetting. They are expressions of the same sort, the wish to remember something that they wish had happened.

Rather peculiar to one form of insanity, the paranoid state, is the disturbance of personality. The symptom is usually due to a system of delusions becoming so complex and organized as to demand a change or transformation of the personality to fit the environment. This may result in the patient's believing that he is some figure of history. Or he may cease in his own belief to have any person at all. Occasionally, when more than one set of well systematized delusions occurs, several personalities are found in one person, and the one active at a given time will depend on which set of delusions is at the height at that particular time. There is usually a complete amnesia between the different personalities, no one remembering any of the acts or characteristics of the others. These are cases of dual or multiple personalities.

One more set of symptoms is rather important in that it refers to the effect of some of these mental symptoms on the motor volitional system. These are referred to as disorders of action. Usually a mental excitement results in physical activity increase, and mental depression results in decreased physical activity. These may be reversed. Other disorders of action are the impulsions and compulsions. An impulsion is the uncontrollable desire to perform an act. Common examples are pyromaniacs, kleptomaniacs, and dipsomaniacs. A compulsion is an urge to do something which the patient does not want to do, and frequently the act is very disgusting and abhorrent to him. In refusing to act when the compulsion develops, the patient suffers acutely.

In a subsequent article the author will deal specifically with the pure psychoses (paranoia, dementia praecox, or schizophrenia, and manic-depressive insanity); also with the injury- or disease-caused insanities (paresis, the senile dementias, toxic insanities).

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VITALLIUM

Plates Used to Repair Skull Defects

Many a soldier came home from the last World War with a metal plate in his head where a piece of skull had been shot away or so crushed that it had to be removed. Soldiers and civilians similarly injured in the present war will have their skull defects repaired with vitallium plates, it appears from a report by Dr. Fred W. Geib, of Rochester, New York, in the *Journal of the American Medical Association.*

Vitallium, an alloy of chromium, nickel, and cobalt, at first proposed for dental use, "makes the strongest and least complicated plastic repair of the skull known," Dr. Geib states in a *Science Service* report. "It is rigid, stronger than bone, non-corrosive and inexpensive and requires a much less complicated cranioplastic operation than any in use at the present time. The patient can be back at work on heavy duty within three weeks after the operation."

Dr. Geib's patients were not wounded soldiers; they were civilians, one of whom had osteomyelitis of the skull following industrial injury. The other two had brain hemorrhages which caused such pressure that pieces of skull had to be removed to save their lives. Grafts of bone from the patient's ribs and cartilage have recently been used to replace the missing skull piece in such cases.

The vitallium plate which Dr. Geib recommends is cast according to a pattern of the defect in the patient's skull. Slots are cut into it from the outer edge, so that it can be bent to fit the skull. Lugs extend over the edges of the skull, and the plate is screwed into the skull through holes in these lugs. The operation of inserting the plate and fastening it to the skull takes about one hour.

The soft tissues beneath the skull grow up around the vitallium plate and through the slots in it, completely incorporating it in a soft, gelatin-like covering. No harmful conditions in either skull, plate, or tissues under it have been found in any of the patients, the first of whom has now had his plate in place for two years. After the death of one of the patients from another condition, his skull was carefully examined and the findings showed how the tissue had incorporated the vitallium plate and was holding it firmly in position as if it were part of the tissue. Vitallium has been used within the last three years in other types of bone surgery by two other groups of surgeons.

BURNS

Announcement of New Treatment With Sulfadiazine

Spraying sulfadiazine, one of the new miracle sulfa drugs, directly on burns is being hailed as the most effective method of treating burns yet devised. At the Johns Hopkins Hospital, in Baltimore, 114 badly burned patients were swiftly healed by the new method announced by Dr. Kenneth L. Pickrell, of the hospital's surgical department, says *Science Service.*

Burned areas "healed more rapidly than with any form of treatment previously used at the Johns Hopkins Hospital," surgeons on the hospital staff declare. Some of them believe the sulfadiazine method will revolutionize the treatment of burns, eliminating the need for skin grafting and plastic surgery to efface scars and correct deformities.

No preliminary washing or cleaning of burned areas is needed. The nurse starts spraying the sulfadiazine while the surgeon is scrubbing his hands in preparation for removal of blisters and loose tissue. The sulfadiazine allays a great deal of the patient's pain and a narcotic may not be needed.

How to Make a Mastodon

Students of Paleontology Reconstruct a Model of Amebelodon from Fossils

C. STUART JOHNSTON
Department of Paleontology, West Texas College

FOSSILS of an ancient, long-jawed mastodon named Amebelodon, that lived in Texas in the Pliocene Epoch of the geologist's Tertiary Period, have been used at the West Texas College as the basis of a life-size restoration of this little-known member of the large and widely variant mastodon family. The amebelodon was not so large as its more familiar relative of comparatively recent geological time. It had at the end of its lower jaw a pair of tusks prolonged and in near contact at the outer ends so that, together, they constituted a long, narrow scoop, prod, or "crowbar" for uprooting and digging out the plants on which it fed.

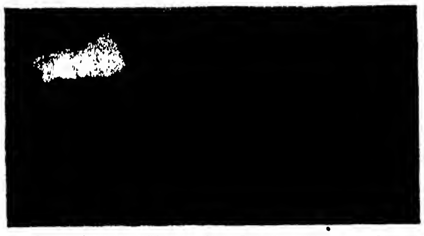
The first step in the restoration of this mammal, which lived about 5,000,000 years ago, was the modeling of a small figure seven inches in height. The fossil limb bones of the actual animal then were placed in position on the laboratory floor and full-size sketches were made of both the side and top views. From here on the actual fossils were not needed.

The sketches thus made served as a guide in constructing the framework. This was made as rigid as possible, with strong rollers at the end of each leg. The legs were constructed on two-by-four scantlings. The general surface of the animal was built of wire screen placed on the framework, stayed and made rigid by ordinary wooden laths. In order to obtain lightness, this wire screen, or hardware cloth, was placed as near the final surface as possible.


First a seven-inch model of the extinct mammal was made

After covering the framework with the screen, to approximately the general contours of the original animal, the structure was then covered again with a layer of burlap dipped in molding plaster. This served as a base upon which the final modeling could be done.

When this burlap base was finished and dry, it was sized with a thin solution of flake glue (colored, so that in putting it on it would be easy to note which parts had been thus sized, and which had not). In addition to sizing the plaster, the glue acted as a binder to the final layer which was to be placed upon it.


Next, a life-sized framework of common lumber was set up


Framework covered with screen, ready for burlap and plaster

This final layer, into which the skin texture and surface detail were to be worked, was made of papier mâché, a strong, hard, yet very light, material. This was prepared by making a pulp of newspapers. This pulp was then mixed as needed with molding plaster, yellow dextrin, and glue. The mixture was prepared with equal parts of molding plaster and paper pulp, to which was added about one fifteenth by volume of yellow dextrin. To a gallon of this mixture a teaspoonful of glue was added to retard setting. By increasing the percentage of dextrin and plaster a harder material may be produced. A mixture such as this sets slowly, giving ample time for working in and modeling the details.

After the papier mâché was placed on in the desired position, it was covered with finely woven cheese cloth. This served the double purpose of helping to give skin texture, and at the same time hold the papier mâché in position until it had time to set. It is also much easier to model the papier mâché with the cheese cloth covering than without it—wrinkles are easily worked into the material, thus giving a life-like appearance.


Burlapped and plastered and ready for final papier mâché

Glass eyes about an inch in diameter, such as those used in commercial taxidermy for mounting antelope heads, were set in place. Heavy, black eyelashes were made from the bristles of a dust brush.


Papier mâché applied and skin modeled in it. All finished

Finally, the completely modeled animal was given a coat of flat gray paint, applied with a brush, so that high lights and shadows might be worked in where desired.

This animal was typical of the western plains about 5,000,000 years ago and is thought to have inhabited the forested region along the streams and water courses. The size of the ears and the length of the trunk are, of course, problematical, but otherwise the proportions are believed to be scientifically accurate.

EDITOR'S NOTE: Amebelodon, discussed above, was a mastodon, as stated, but was not *the* mastodon. What we commonly know as *the* mastodon was, however, only one of a whole family of mastodonts (correct plural spelling), and

its claim to fame as *the* mastodon rests merely on the circumstance that this rather recent animal, *Mastodon americanus*, is the one so often dug up from our swamps. Yet there were numerous other members of the family, each different, at different times in relatively recent earth history—say, the past 10,000,000 years—also different contemporary races at each time. The amebelodon was one of these, neither recent, like *the* mastodon, nor very early; it stood roughly midway in time. For illustrative comparison with motor car models: If the familiar mastodon was a recent model of about 1939, though no longer manufactured, then the amebelodon might have been one of the models of about 1915. The model did not long survive—maybe no more than a million years or so. It either wasn't altogether satisfactory on the road, or the conditions changed, causing better engineered models to forge ahead.

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"CRAZY DRIVERS"

May Actually

Be Insane

The "crazy driver" who whizzes by you at 70 miles an hour may be insane — literally. Probably the most vicious group of dangerous drivers on the highways are the mentally ill, according to Dr. Lowell S. Selling of the Psycopathic Clinic of Detroit's Recorder's Court, reports *Science Service*.

"Even in cities where there are a number of highly developed psychiatric and mental hygiene clinics," he said, "there are individuals who are suffering from mental diseases. Some of them have never been sent to a doctor and in many cases their own families do not know that they are insane. The average layman does not recognize symptoms of insanity unless the patient's behavior is extremely bizarre."

Some of the mentally ill have grandiose ideas. They think they are more important than other people and that they can pay for any amount of damage they might do to life or property with their cars. Some are nervous, unstable, and excitable so that in an emergency they do the wrong thing.

Sufferers from the mental disease dementia praecox, or schizophrenia, are likely to include the type of person with violent suspicions and false ideas that he is being persecuted by the police or mysterious organized groups. Such a person may interpret a gesture of a pedestrian as being a sign to some conspirator in a plot and deliberately run his car into the pedestrian to kill him in what is imagined to be "self protection."

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TIMBER: An all-time high from timber sales on national forest areas was reached at the end of the fiscal year of 1941. Receipts were $4,789,040, compared with $4,389,893 in 1930, the previous record.

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THE UNIVERSE

Pictured By A

"Multiplication Table"

A new picture of the Universe from the smallest things to the greatest is given by a sort of multiplication table suggested by M. Davidson in the *Journal of the British Astronomical Association*. Taking his cue from Sir Arthur Eddington's famous lines in his book "The Expanding Universe,"

"A hundred thousand million stars make one Galaxy;

"A hundred thousand million Galaxies make one Universe"

Dr. Davidson proposed a series of things each of which multiplied by 100,000 would give the size of the next in the series, according to *Science Service*.

Beginning with the electron, as the smallest thing known in the Universe, the multiplication table of the Universe would run like this:

A hundred thousand electrons side by side stretch the width of an atom.

A hundred thousand atoms side by side stretch the width of a white blood corpuscle.

A hundred thousand white blood corpuscles side by side reach a length of 13 feet.

A hundred thousand times 13 feet is the radius of the minor planet Vesta.

A hundred thousand times the radius of Vesta will reach from the center of the Sun to one-third of the distance to Mercury—the planet nearest the Sun.

A hundred thousand times this distance is one-tenth of a light year or the distance that light, traveling 186,000 miles per second, would reach in the tenth part of a year.

A hundred thousand times a tenth of a light year is of course 10,000 light years, one time supposed to be about the size of our own Galaxy or Milky Way system, but now believed to be more than ten times as large.

A hundred thousand times 10,000 light years is a billion light years, a distance that would stretch across the whole Universe now visible to astronomers.

Here ends the table of M. Davidson, but not the Universe. With each increase in the size of telescopes, with each increase in the sensitiveness of photographic plates, the visible Universe is extended. And the number of stars coming in with each increase indicates that the end is still far away. Every theoretical model of the Universe, beginning with Einstein's, has made the radius of the Universe thousands of times greater than that of the part now visible.

BETTER PLYWOOD

Results from

Improved Adhesives

The plywood industry is on the threshold of a new production era, according to a statement to a Senate committee by Paul H. Appleby, Undersecretary of Agriculture. "Output," he said, "increased from 200 million square feet in 1932 to 700 million square feet in 1936 owing mainly to the inherently fine qualities of plywood as a structural material—high strength for its weight, for example. But now plywood far superior to that formerly used is available by virtue of improved plastic adhesives that are impervious to water. Furthermore the properties of wood and plywood alike can now be modified almost at will by impregnation with resin-forming materials followed by heat and pressure.

"This new type of plywood, waterproof and capable of being compressed and molded to form odd shapes and integral units, lends itself to almost unlimited development. In aircraft, for example, it can be used in the construction of wings, leading edges of wings, wing tips, fuselages, ailerons,

flooring, bomb-bay doors, instrument panels, and so on. Its use for such purposes would tend to relieve the aluminum alloy situation and at the same time would bring into the defense program an industry whose resources of labor and materials have not yet been tapped to the extent possible."

CUTS GLARE

Etching Glass Surfaces Reduces Reflection

RESEARCH in television in RCA Laboratories has led to a new chemical process to reduce extraneous reflections from glass. It now becomes possible virtually to eliminate the streaks that glare across show windows, framed pictures, ground-glass screens on cameras, and other glass surfaces or panels. For example, the glass faces of electric meters and the multiplicity of dials that confront airmen, as well as those of automobilists, now can be made reflection-proof, minimizing chance of error in reading.

Success in this conquest of reflections from large surfaces was achieved while striving to improve contrast on television cathode-ray tubes. Since the images are "painted" on the glass face of a cathode-ray tube, thence to be passed on through a thick glass protector plate to a glass mirror, the challenge of reflections was baffling. The experts, in their study, went back as far as 1900 to pick up an important clue dropped by Lord Rayleigh, the eminent English physicist.

He had jotted down in the record of his observations that hydrofluoric acid, diluted one part in 200 of water, removed a thickness of glass corresponding to about one-quarter wavelength of light each hour. Following up this clue, the research experts discovered further that an application such as Rayleigh used could impose on a glass surface an almost invisible film of low reflecting power.

Extending the investigation of the effects of hydrofluoric acid liquid and vapor on glass, new signposts were found for clearer vision in television and in the wide fields in which glass is used, whether in tiny lenses or big show windows. Of particular interest to the optical field is the fact that, as the amount of reflection is reduced, the light transmitting quality of the lens substantially increases and greater contrast results.

Dr. F. H. Nicoll, research scientist of RCA Laboratories, developed the new formula. His process is based upon the exposure of the glass surface to hydrofluoric acid vapor. The vapor etches away a small amount of surface, leaving a thin, transparent film of calcium fluoride measuring in thickness approximately one-quarter wavelength of light. Exhaustive tests show that the film withstands hard rubbing, that it can be washed with water, alcohol, and a number of other solutions, and can be subjected to relatively high temperatures without danger of serious impairment.

Half treated; half not

Major contributions to this same field, depending upon coatings added to the surface of the glass, have been made by Doctors John Strong, Katherine Blodgett, and C. H. Cartwright. These other methods, developed so far, have not been applicable to large sheets of glass, as is Dr. Nicoll's process, or, in some cases, they have been lacking in economy and in resistance to wear and weather.

TIN FINISH

Can Be Applied Rapidly, Easily

APPLICABLE to all copper and brass surfaces, a new material for producing a tin finish may be applied in ten seconds. In many substances this process can replace slow boiling methods of tin plating. The finishing solution is prepared by dissolving sixteen ounces of sodium cyanide and six ounces of Bon White paste, made by the Alrose Chemical Company, in a gallon of boiling water.

When cooled to room temperature, no further heating is necessary and no adjustment is required, as the material is completely plated from the solution. The life of the solution depends on the production volume. Enamel and glass containers are used and the work can be conveniently handled in baskets or on wire supports.

This new product, it is claimed, assures an inexpensive, highly effective white finish and, being pure tin, offers appreciable tarnish resistance. The new finish has already found wide acceptance in many industries.

POOR MILEAGE

Generally Ignition is to Blame

IF YOU'VE been wondering why your car doesn't give you better gasoline mileage, take the advice of an expert and look for the trouble where 85 percent of such difficulty lies—in a faulty ignition system.

This advice, based on Ford Motor Company experience with cars in the field, is offered at a time when the government is urging public support in conserving fuel, oil, and rubber.

Most people blame the carburetor when their cars seem to be using excessive amounts of fuel. In fact, a majority of car owners put the finger of blame on almost everything else but the ignition system. They usually start tinkering around with the delicate carburetor adjustments, or ask service men to change the adjustments.

But take it from the experienced automotive engineer, when you're having trouble with fuel economy, you'll find in four cases out of five that the ignition system is out of kilter.

If the timing is advanced too far, the fuel mixture in the cylinder fires too soon. This causes the pistons to work against (instead of with) each other and results in what is known as "piston ping." If the timing of the spark is retarded too much, combustion in the cylinder is not completed when the exhaust valve opens and the unburned fuel mixture is forced out

and burned in the exhaust manifold.

Findings show that poor spark also causes much of the gasoline mixture to be exhausted from the engine without burning. The sources of poor spark are numerous but here are a few of the more important: low battery charge; bad wiring connections; burned, pitted, or badly adjusted breaker points in the distributor; a "short" in the coil, rotor, spark plugs, or some other parts of the high-tension system; faulty coil; and dirty, badly spaced or worn spark plugs.

COLOR COILS

Modify Light From Fluorescent Tubes

PLASTIC coils have been developed which color fluorescent lights, control their brilliance, and correct color distortion. Made of tenite, a shatterproof plastic, the diffusing coils fit tightly over the tubes and can be used for their decorative effect alone.

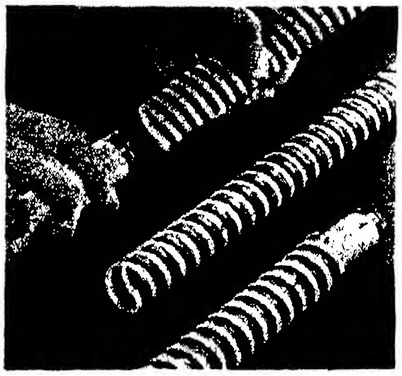
The diffusers are produced by winding thin, transparent, and translucent strands of tenite into tight, spring-like coils. Since the plastic has an unlimited color range, any shade or combination of shades is possible.

Color correction for white and daylight fluorescent light — both inherently deficient in red rays— can best be obtained with coils made of red and clear strands of tenite wound together. An insufficient amount of red rays in light can give a "cold" effect and make red and other colors containing red, such as brown, appear unnaturally dark. Pink coils not only serve as diffusers, transmitting more than 70 percent of the tube's light, but they also aid in correcting color distortion.

Illumination engineers and interior decorators can now obtain entirely new effects in lighting. The coils are virtually indestructible and will outlast many lamps. They are molded by extrusion. In this process, continuous lengths of the heated plastic are forced from a die much as toothpaste is squeezed from a tube. The plastic hardens when cool and is coiled in the desired lengths and diameters.

Although the size and wattage of fluorescent tubes may be changed in order to vary the amount of light available, the brightness of any single tube once installed is constant, it is pointed out. Tenite coils are a step towards solving the problem of varying this intensity. Since the plastic is manufactured in forms ranging from clear transparency to opacity, the amount of light shed by a tube sheathed in tenite depends upon the translucency of the coil.

The most outstanding result of tests so far made is the ability of



They remove glare, add color

the solid pink plasticoils to transmit a great amount of light. This ability, together with its high spectral transmission of red rays, and its cutting down of transmission of yellow rays, makes it an even better diffusion shield than the clear because a degree of color correction can be obtained.

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AUTOMOBILES: Over the years, more than 1500 different makes of automobiles, propelled by electricity, steam, or internal-combustion engines, have been built in the United States.

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EYE DEFECTS

Can Often Be Corrected

RECENT advances in eye-diagnostic and corrective techniques make it possible to rehabilitate many of the 123,000 men who have been rejected for military service because of defective eyes, according to Dr. R. J. Beitel, member of American Optical Company's bureau of visual science. In substantiation of his assertion, he referred to a Southbridge youth, Lionel Proulx, who, rejected by the Army Air Corps because of poor eye convergence, had his eyes brought to normal by eye-coördination training with the aid of prisms and the metronoscope, an instrument for correcting disabilities in connection with reading.

After this training, Proulx was able to pass the Royal Canadian Air Force physical examination and in the near future expects to use his reconditioned eyes in flights over Germany.

According to Dr. Beitel, many men with similar visual conditions, who have been rejected by Army doctors, can have their eye efficiency brought back to normal by such orthoptic or other corrective treatment.

BRUISED FRUIT

Cushions Reduce Spoilage Loss

TO prevent bruising of fruit while it is being graded, and thus decrease losses due to spoilage, one of the large Georgia peach growers now uses the new latex foam cushioning material on his grading and sorting tables, it is reported by The B. F. Goodrich Company. Similar use has also been made of the product by a large North Carolina potato grower.

LOST CIVILIZATION

Ivory Eyeballs, Jet Pupils, Carved Masks

FURTHER information about the strange lost civilization discovered at Point Hope, Alaska, last year, was reported by Dr. Harry L. Shapiro, associate curator of Physical Anthropology of the American Museum of Natural History, on his return after a season's work at this site.

This throws added light on the discoveries made in 1939 and 1940 by an American Museum-University of Alaska expedition under the direction of Dr. Froelich G. Rainey, which located the vast remains of a prehistoric town on the ancient migration route from Asia to America. Differences in the color of the vegetation disclosed five long-avenues of some 600 buried dwellings that probably housed 3000 people on the barren gravel spit of Point Hope, 130 miles above the Arctic Circle. Subsequent excavations in the graves that led out from the town site uncovered remains and implements very dif-

ferent from those of the prehistoric and present-day Eskimo tribes of that region. This ancient culture has been labeled "Ipiutak" from the Eskimo name of a small spit of land near the site.

In log-walled tombs, constructed in rectangular shape, well-preserved skeletons were found with their implements for use in the after-world. The most exciting of the finds were those in which the skulls were equipped with large ivory eyeballs, inlaid with jet pupils, and fantastic ivory carvings evidently used for decoration. The graves also contained many arrowheads, fine flint tools, needles, and other artifacts of daily living. The carvings and implements made by these people were sufficiently different from the known Eskimo cultures to encourage the American Museum in a further search to trace the origin of the unknown race.

The Ipiutak culture is especially distinguished by a unique ivory art, an abundance of finely chipped flat tools, and by an emphasis on land hunting gear. Many implements widely distributed among all previousy known Eskimo people are absent. Moreover, in certain respects the Ipiutak culture, although the oldest in the area, is more complex and developed.

Dr. Shapiro and Dr. Rainey excavated 500 tombs in an area covering an extent of six miles leading out from the Ipiutak town. One of the most interesting discoveries is a beautifully carved ivory mask made in several sections, with the inset ivory eyes peculiar to the Ipiutak burials. The mask was found in a tomb enclosing the remains of a man, woman, and child. The body of the child was resting on the knees of the man and the huge ivory mask covered the body of the child. The sigificance of this, and other Ipiutak burials is unknown, and as strange to the living Eskimos on Point Hope as it is to anthropologists.

SHATTER-PROOF

Non-Bursting Oxygen

Tanks for Airmen

That steel tankful of breathing oxygen means life to a war-plane crew flying at 20,000 feet, but with stray bullets in the air it's like sitting on a time-bomb. When a machine-gun slug hits that vital oxygen cylinder, it's quite likely to explode with a roar and hurl deadly jagged pieces of steel through the cabin as the terrific internal pressure of as much as 1800 pounds per square inch is released.

Above: **One that can't burst and one that did.** ***Right:*** **Testing containers with .50-caliber armor - piercing ammunition**

Since the steel chunks could wreak more destruction than bullets, military air experts were quick to realize the danger of using ordinary oxygen cylinders in modern combat flying where an otherwise harmless stray bullet might knock out the entire crew and cripple the plane. This was the problem put up a few months ago to engineers of Walter Kidde & Company, maker of oxygen breathing cylinders, and it was solved by the development of a completely shatter-proof oxygen cylinder that would not burst when riddled by .50-caliber armor-piercing bullets. The nature of the metal used in the new tanks is kept secret. Bullets will penetrate it, as one of our pictures shows, but the pressure so released will not fracture the tank.

FOREST DAMAGE

In Michigan Caused

By Over-Cutting

Forest resources in Michigan's Upper Peninsula are threatened with serious injury because of over-cutting in the area. Some 758 million board feet are being taken annually, although good management would allow not more than 589 million, if existing forests are to be maintained and a large group of industries supported on a permanent basis.

The Forest Service of the Department of Agriculture reports that the allowable yield could be increased within 40 years to 650 million board feet, and eventually to 1000 million feet a year, but the increased output, and even the maintenance of present production, depends upon the creation of sustained yield units and the elimination of timber "mining" or destructive methods of harvesting.

At the present annual rate of 758 million feet it will not be many years before usable forest resources are gone, says a new Forest Service report on the Upper Peninsula. Loss of resources would be followed by unemployment, lower standards of living, financial breakdown, and resultant distress. However, the foresters point out that these conditions can be avoided by good management of the remaining forests—proper cutting methods, close utilization of low grade timber, and careful protection of young growth.

A reduction in the present cutting rate, while producing temporary unfavorable conditions in a few cases, will result in the creation of permanently improved conditions for the area as a whole, says the report.

FIRE-PROOF

House Insulation Checks

Spread of Flames

A dramatic demonstration of the fact that glass-wool insulation, in addition to helping keep homes warm in winter and cool in summer, serves effectively as a fire wall to check the spread of flames was recently provided by a fire in a home of wood frame construction with a shingle roof. Some years

ago the house was insulated with glass wool blown into the sidewalls and into the ceiling of the second story.

The fire started when sparks from the incinerator ignited the roof. The roof and roof rafters burned fiercely, but the insulation of the second floor ceiling acted as a fire wall and, although the heat of the flames was intense, the joists of the second floor ceiling burned very slowly.

The second floor ceiling finally gave in, but only under the weight of the fallen chimney which was constructed at an angle in order to pass through the ridgeway. Even after the cave-in of the second floor ceiling the insulation continued to protect the flooring of the second floor so effectively that in only one place was it sufficiently damaged to require replacement.

Due to the degree to which the insulation slowed the spread of the fire, the occupants of the house, with some outside assistance, were able to remove almost all clothing, bedding, and personal effects from the second floor before the ceiling fell.

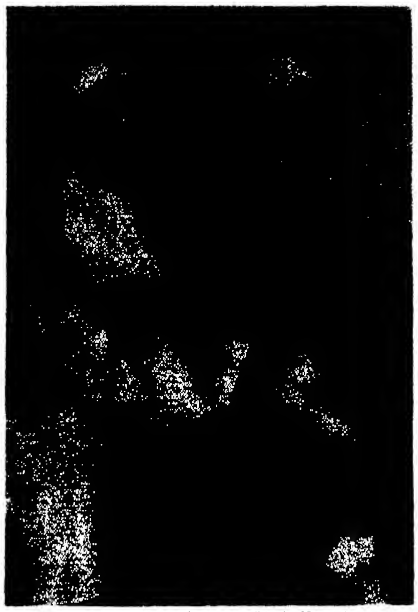
STARTER SWITCH

A new "no-blink" starter switch which will end a fluorescent lamp's life when it has reached the stage where it blinks on and off, has just been announced by Westinghouse. Designed specifically for the 40-watt Mazda fluorescent lamp, the new switch will eliminate blinking and flickering of burned-out lamps. Starter switches will last longer because they will not be impaired by repeated attempts to start lamps. The "no blink" switch makes the group replacement idea feasible when lamps are installed in inaccessible places.

HEAT LAMP

Built-In Reflector, For Home Use

A new infra-red lamp bulb with self-contained reflector and two new fixtures, including a table and a floor model, have resulted from General Electric's solution to the problem of eliminating aluminum reflectors in home-type heat lamps. The new 250-watt, 115-volt lamp is mushroom shaped to accommodate the correctly designed reflector built in behind the filament. Reasonably uniform distribution



Uniform heat-ray distribution

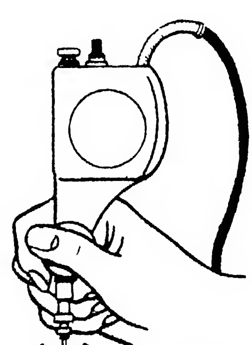
of the heat rays is provided by the finish and contour of the reflector. At close range, the energy is distributed over a small circle and at high intensity. Exposures taken at greater distances increase the area over which heat is distributed, but the intensity decreases with the square of the distance.

Because it is sealed within the bulb, the reflector is protected from the tarnishing effects of air, dust, and water; its original condition is preserved to provide maximum reflection efficiency for the life of the filament. The filament has been designed to operate at a cherry-red heat so that glare has been reduced to a minimum. The color is pleasing and comfortable to the eyes and is readily associated with infra-red radiation.

VIBRATING

Hand Tool Of Many Uses

Both home craftsmen and professional mechanics will find a wide variety of uses for a new vibrating



Engraving with new hand tool

hand tool recently announced by Burgess Handicraft Supplies. This tool, shown in an accompanying drawing, operates on any 110 volt, A.C., 60 cycle line.

Delivering 7200 strokes per minute, the tool point can be used for engraving on jewelry, marking steel tools and parts (except tempered or hardened steel), marking glass and metal signs, and for other similar engraving on a wide variety of materials.

The tool comes equipped with interchangeable steel needle points, and several different types of attachments are available. These include knife blades, hammering tips, and special cutters, all of which are interchangeable in the tool chuck. With these attachments it is possible to do high-speed wood carving and a wide range of metal-tooling, leather working, and other pounding or pressing operations.

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SEA SAFETY: Asbestos shields on lifeboats of British oil tankers protect crews from torpedoed ships when surrounded by burning oil and can also be used as sails.

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OLDEST PLASTIC

Bitumen Still Can Be Improved

While we talk glibly of the fact that bitumen, in which we include asphalt, is the oldest plastic, apparently having been used by a very old boatbuilder, it remains a fact that industrially bitumen became an important material only when the chemical industry demanded it as an anti-corrosion compound, when the electrical industry found it useful as a dielectric, when road building assumed importance because of the growth of the motor industry, and when this last found it useful as a molding material for holding acid accumulators.

Nevertheless, there is still much to learn about bitumen and there is still room for improvement. Certainly the road constructors are not too pleased with it, for it has poor adhesion to the mineral aggregate which it is presumed to bind. Recently Dr. C. Mack, of the Imperial Oil Company, Ontario, discussed this adhesion in a paper at the Chemical Society. There is no doubt that this property can be improved by the addition of certain agents. Among these copper sul-

fate and ferric chloride were mentioned as being useful; presumably in the latter case some oxidization or decomposition to more viscous and more adhesive compounds takes place.

It is interesting to note a recent patent by the Standard Oil Company which avoids direct admixture with bitumen, but induces adhesion to a road surface by covering the latter with a film of lead naphthanate, a material of great "stickiness," before finishing with bitumen.

There is little doubt that the adhesion of bitumen to mineral aggregate can be achieved very easily, but the chief deterrent of most methods lies in the fact that economically bitumen can stand little or no increase in price.

These notes carry sufficient interest for plastics generally, since their modification in one way or another grows apace. It is obvious that these problems are akin to plasticizing and that the road constructors can learn something from the plastics industry. The reverse is also obviously true. — *Plastics* (London).

CLOUD HEIGHT

Measured With Light in Daylight

A TINY, 1000-watt mercury lamp developed for searchlights and television studios has been used to solve a vital problem of aviation—the daylight measurement of the height of clouds from the ground.

Maurice K. Laufer and Laurence K. Foskett of the National Bureau of Standards discovered that by projecting the light from a General Electric high-intensity water-cooled quartz mercury lamp, and noting with a photoelectric cell the "splatter" of the light where it hits the cloud, the altitude can be calculated by triangulation.

"During the daytime," they explain in the *Journal of Research of the National Bureau of Standards,* "dark overcast clouds at an elevation of 9000 feet have been readily detected. For cumulus clouds illuminated by direct sunlight and having elevations up to 4000 feet, the detection is positive."

The projector consists of the lamp located at the focus of a 24-inch parabolic mirror having a 10-inch focal length. The detector consists of a vacuum-type phototube placed immediately behind a diaphragm with a slit opening 3/25 by 11/16 inch located at the focus of an eight-inch plano-convex condensing lens.

The narrow beam from the 1000-watt lamp is projected into the sky at a frequency of 120 flashes per second; the rays scatter when they hit the clouds. This light scattering is detected by the photoelectric cell located at a known distance from the lamp and adjusted for this flash frequency that will distinguish the beam from background light.

The cloud height then is determined by the solution of the triangle formed by the line of the beam to the clouds, the angle of the photoelectric cell sight upon the clouds, and the base line connecting the beam projector and the phototube.

FLEXIBLE PLUG

Eliminates Broken Wires, Short Circuits

THE operation of "wrist action" electric plugs, designed to eliminate kinking and twisting of electrical appliance cords, is clearly shown by the "Lucite" demonstra-

tion model recently produced by the Davis Manufacturing Company and illustrated in one of our photographs.

Swinging freely in any direction, the swivel plug takes up practically

It spins around

all the bending and twisting which constantly occurs in attachment cords for irons, toasters, and other appliances. Thus the cord troubles which often come at the point where the cord enters the plug are eliminated in the wrist action plug; the swivel action prevents twisting of the cord. No wires enter the plug.

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LUMBER — Nearly 1,000,000,000,000 board feet of lumber have been cut from timber taken off American forest lands since 1909. This amount of lumber laid in a plank walk two feet wide would reach from the earth to the sun—a distance of 93,000,000 miles.

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DUST STORMS

Can Build Up As Well As Tear Down

If dust storms aren't up to one thing, apparently they are up to another. A few years ago they were awarded responsibility for digging out the "dust bowl." Now it appears that they also pile up bluffs.

Huge dust storms which swept the United States more than fifty thousand years ago created many of the large clay bluffs that line the highways of the Mississippi valley, according to Dr. Earl T. Apfel, professor of geology at Syracuse University.

Large drifts of wind-blown clay, found throughout the Central Plains of the United States and in small patches in Connecticut, Massachusetts, New York, and elsewhere, known as "loess," were deposited by huge "dust storms" which raged in North America during the Great Ice Age, more than fifty thousand years ago, Dr. Apfel says. The storms occurred in periods between successive intervals of glacial activity, and the loess deposits are usually classified according to the interglacial interval in which they were formed. For instance, the Loveland loess heaps, found from eastern Iowa to western Nebraska, are complex in origin and probably were built up from deposits laid down in several interglacial intervals.

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ACCIDENTS: More than three out of every five traffic fatalities during 1940 resulted from accidents that occurred in rural areas.

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LIGHT, PLUS

Flexibility Featured In Illuminated Magnifier

First described some months ago in these pages, a combined magnifying lens and light unit, particularly adapted to first-aid work, is now being produced in a new style, more compact, and with an improved mounting bracket. One of our accompanying photos shows both the old and new models; both give magnification and light wherever needed and both can be moved about with a minimum of effort, remaining in whatever position they are placed. Brackets available include a type that may be attached to the arm of a chair or table and one that is mounted on a pedestal.

CORYPHODON

Skeletons of Hippopotamus-Like Animal Discovered

Several skeletons of an ancient hippopotamus-like animal known as coryphodon, together with "spare parts" consisting of extra skulls, limb bones, jaws, and so on, have been found in Colorado by an expedition of the Field Museum of Natural History, under the leadership of Bryan Patterson, assistant curator of paleontology.

Since there are at present only three reasonably complete coryphodon skeletons in all the museums of the world, this new find constitutes a real scientific treasure trove.

Coryphodon was not closely related to the hippopotamus, despite its superficial resemblance. The evolutionary line to which it belonged has become totally extinct. The animal lived in the Eocene period, near the beginning of the Age of Mammals, reckoned at between 50 and 60 million years ago. —*Science Service.*

DECIPHERMENT

London Scientists Perfect Reading of Charred Documents

Improvements over older methods of preparing charred documents for decipherment have been worked out by two technicians at

Helps in removing particles from eyes and in other first-aid work

the Metropolitan Police Laboratory, W. D. Taylor and Henry J. Walls, who, in *Nature* (London), state that, "in spite of its topical interest, the subject is not a new one; but we have already obtained results which we think, taking into consideration the simplicity and general applicability of the method, mark a distinct advance on anything hitherto recorded.

"Briefly, the method consists in treating the document with chloral hydrate; this substance appears to exert an as yet unexplained 'clarifying' action on the burnt figures or letters. The chloral hydrate is applied in a 25 percent alcoholic solution; after several applications, the document being dried at 60 degrees, centigrade, between each, a mass of chloral hydrate crystals will form on the surface, and at this stage a similar solution containing 10 percent glycerine is applied and the document dried as before. It may then be photographed. The most suitable type of plate is a contrasty non-color-sensitive one.

"The method is equally satisfactory for typescript and for printing, and with certain modifications has been found to restore writing. Furthermore, the reading matter is restored equally on both sides of the paper.

"Certain distinct advantages which are possessed by this method are: (1) it appears to be applicable to any type of document; (2) it is fairly quick; (3) it has never yet in our hands failed to produce a readable result; (4) it requires no special apparatus other than a copying camera.

"It has so far eluded us to find a satisfactory explanation in physical or chemical terms of this action by chloral hydrate."

SUGAR

Identified by New Polarizing Instrument

IDENTIFYING and measuring sugar in baby's diet has been simplified by development of a new medical and research instrument which employs light-control polaroid film to determine if the sugar is the proper type.

Announced by the American Optical Company, the new polarimeter functions because sugar has the power of rotating the direction of polarized light, light vibrating in one plane only. Identification of sugars in diets is important because

only certain kinds pass as nutritional factors through the intestinal walls to be absorbed by the blood stream.

The new instrument enables the scientist to determine that honey, for example, is largely a left-hand

Checks on the sweets

sugar, a levulose, because it rotates polarized light counter-clockwise; also that corn syrup rotates polarized light clockwise, and is a right-hand, or dextrose, sugar.

In the new polarimeter, which resembles a small telescope, light from a sodium flame passes through a polaroid disk, a sample tube, another polaroid disk, a telescope objective, and an eyepiece. Crossing the polaroid disks darkens the tube. But if a sugar solution is placed in the tube, the field becomes light. Rotating one of the disks restores darkness. A scale and a drum on the instrument provide means for measuring the sugar in the solution.

ELECTRIC HEAT

Removes Paint, Putty, Without Damage

Electrical appliances for quick and safe removal of paint and putty have recently been designed by Tamms Silica Company. The paint remover, which plugs into any convenient electric outlet, is held against the surface from which the paint is to be scraped; quickly the paint softens, permitting easy removal with a putty knife. The handle of the appliance is well insulated to protect the operator against the heat generated. This paint softening appliance comes in two sizes, one for use on large painted areas and a small size for use on window frames, door jambs, furniture, and so on.

The putty softening unit operates on the same principle of applying electrical heat locally. The device is so shaped that, after plugging into an electric light socket, it can be held against the line of putty surrounding a window sash. The heat softens the putty quickly whereupon it may be removed with any suitable tool. It is claimed that the risk of glass breakage is practically eliminated.

GROWING AUTOS

Farm Crops and Animals Do Their Share

The automobile industry is one of the farmer's best customers, according to a report based on the extensive use of farm products by the Ford Motor Company in building cars and trucks.

It is estimated that for each 1,000,000 units it manufactures, Ford needs from the American farmer the following agricultural items:

Cotton—69,300,000 pounds, or the annual output of 433,125 acres.

Wool—3,204,000 pounds, or the wool from approximately 801,000 sheep.

Wood—112,000,000 board feet, or 20,500 acres of forestlands.

Cattle—30,000 head to provide 1,500,000 square feet of leather.

Soybeans—600,000 bushels.

Flax—118,000 bushels, equivalent to 17,500 acres.

Tung oil—195,000 gallons.

Hogs—20,000 head, to provide 1,000,000 pounds of lard oil lubricant.

Corn—451,500 bushels, equivalent to 11,280 acres.

Wheat—120,000 pounds as flour used in foundry.

Goats—87,500 head, to provide 350,000 pounds of mohair material.

Jute—5,000,000 pounds.

Pine pitch—2,060,000 pounds.

Sugar Cane—enough to provide 2,500,000 gallons of molasses.

Honey bees—83,000,000 bees, to produce 6000 pounds of beeswax.

Castor oil—150,000 gallons.

Most of the cotton brought to the Ford Rouge plant is used in the form of upholstery cloth and in tire fabric. Wool is used in upholstery and for certain gaskets. The cow plays its part by providing leather upholstering, gasket material and glycerine.

Soybeans have many uses in the Ford industries. Chief among them are in the body finishes, molded electrical parts, and as core oil and bond in the foundry. Flax is utilized in paints, core oil, soft soaps, and

glycerine. Two chief uses for tung oil are in enamels and varnishes and in brake linings.

The hog contributes lard oil for rear axle lubricant and also provides bristles for brushes. Jute goes into carpet backing, and pine pitch is used for foundry resin, turpentine, adhesives, paints, and lacquers. Sugar cane provides alcohol for anti-freeze, shock absorber fluid, and various solvents. Castor oil is used for lacquer and artificial leather and hydraulic brake fluid.

Beeswax is utilized as electrical imbedding compound.

NO CURE-ALL

A Newly Developed Grass Sometimes Repels Some Insects

NUMEROUS reports of the discovery of a kind of grass that repels mosquitoes having been widely disseminated, apparently in rather glowing form, through the daily press, a number of our readers have written for information concerning the find. As is too usual, it turns out to be somewhat limited in value, though valuable — in the tropics.

The United States Department of Agriculture, when asked for data, replied as follows, and this may be taken to pin the account down to the facts even if it does greatly limit the hopes of those concerned:

"Apparently the grass referred to, *Melinis minutiflora*, commonly called molasses grass, has been given considerable publicity as to its repellent qualities against mosquitoes, ticks, and even snakes. There is some question as to its being toxic to insects such as mosquitoes, cattle ticks, and tsetse flies. Experiments conducted at the Puerto Rico Agriculture Experiment Station proved that molasses grass does not kill the common cattle tick. No doubt the oily substances secreted by the grass do act as a partial repellent and in a pure thick stand may tend to prevent development of certain insects.

"The grass is a native of Africa and has been introduced into South America where it has taken hold well. It has been introduced into Florida on several occasions but has never survived the winter there.

"Perhaps additional information regarding this plant and its insecticidal qualities can be obtained from Dr. H. Pittier, P. O. Box 255, Caracas, Venezuela. Dr. Pittier is a botanist who has worked in Venezuela for many years."

Industrial Growth

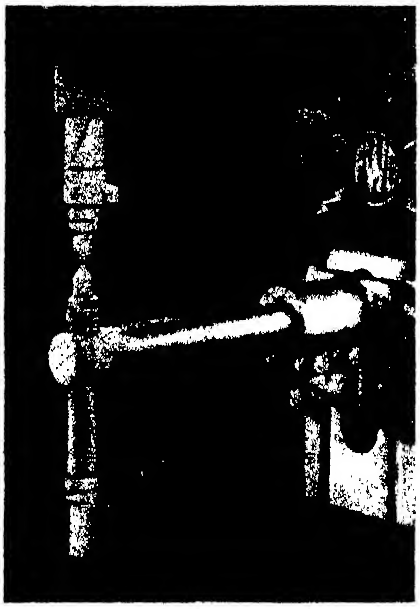
New Products and Processes That Reflect Applications of Research to Industrial Production

COOL WELDING

Refrigerated Points Last Longer, Weld Better

DESIGNED to increase productivity of resistance welding equipment, especially in welding of aluminum and stainless steel, a line of refrigerating units for many types of welding machines is announced by Progressive Welder Company.

Believed to be the first time "refrigerated welding" has been made commercially available, the unit makes possible continuous welding of four to ten times as many spots in aluminum without requiring point dressing.



Frost on the electrodes

When used in combination with a spot welding machine, the unit reduces electrode temperature to a point where—in spite of the high heat necessary to produce a weld—electrodes will be continuously covered with frost. This reduction in temperature has so increased point life that 10 minute runs, continuously, at 100 welds per minute without point dressing are not unusual for the combination of a Progressive three-phase aluminum welder and the refrigerating unit.

The unit can also be used for welding other types of material besides aluminum and stainless, and may be applied to the cooling of industrial coolants, cutting oils, and so on.

The new units are available in a range of three sizes, designed respectively for use with (1) a single aluminum welder, (2) two welders, and (3) a bank of four such welding machines. The units are provided with automatic thermostatic control, all standard safety appliances, built-in dehydrator, heat exchanger, external indicating thermometer, highest efficiency pump with variable pressure.

Peculiarly enough, while the refrigerating unit absorbs a considerable amount of heat, experience indicates that welding machine settings are actually lower than when operating with water cooling. The lower setting of the heat control generally required is probably due in part to the higher conductivity of copper at the lower temperature.

Installation of the refrigerating unit is quite simple. Being self-contained, it is necessary in most cases only to disconnect the water-lines to the electrodes and couple the refrigerator unit inlet and outlet connections to the electrode water piping.

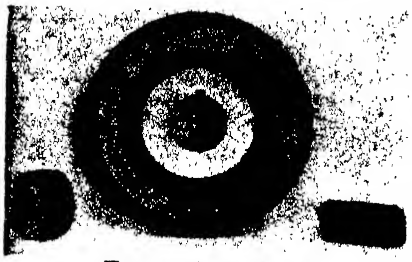
MARKERS

For a Wide Range of Machine Uses

A GREATLY expanded line of markers of various types suitable for cutting slots, notches, knurls, serrations, graduations, and calibration lines on machinery, ordnance, dials, indexing or calibrating collars or rings, bevelled disks, and so on, is now available through New Method Steel Stamps, Inc.

For use where the marks need not be precisely indexed around the circumference or periphery of the parts, markers of the roll type may be employed in any lathe. Where high production is demanded, they may be mounted in a turret lathe, screw machine, or other

high-production machine tool. The marking rolls are suitable for graduating or knurling on steel, bronze, brass, aluminum, or any other workable material. It is also possible for the calibration lines to be limited to a portion of the circumference or periphery, the roll



Types of markers

marker being equipped with stops that prevent repeating the design or markings even though the lathe or screw machine spindle on which the part is mounted continues to rotate.

These roll marking devices are also suitable for use where greater accuracy is required by gearing them to the parts to be marked in such a manner that the calibrations will be precisely located around the circumference. Proper registering devices to suit the design of the specific pieces on which the lines or serrations are to be cut may readily be obtained. The markers are available either with or without corresponding numerals. In some cases the numerals may be added by a separate marker after the calibration lines have been made on the part.

In addition to the more conventional cylindrical types with indexing lines or calibrations around the periphery, graduation markers are also available with bevelled edges, or may be of disk type for producing serrations on the sides of collars, ferrules, and so on. Sizes range from micrometer thimbles up to large calibrated hand wheels on machinery. Calibration lines can be varied in length, with any spacing desired. Similarly, the design of the markings may be varied.

Machine stamps for use in presses may also be obtained with any desired lines or markings.

ZINC PLATING

New Process Utilizes Waste Materials

CHEAP sources of zinc instead of the usual zinc anodes may be used in a new process of zinc plating in

which the zinc is dissolved from galvanizer's skimmings, organic reduction residues, or similar waste materials, by a solution of ammonium chloride and ammonia. Insoluble graphite anodes are used in the plating tank. The plating process reduces the zinc content of the solution.

This new method of zinc plating, known as the Hubbell-Weisberg Process, works at high current densities. This fact, combined with the high conductivity of the solution and careful design of the electrical equipment, makes the process highly economical of power.

Greatest economies with this process become evident when from 1½ to 2½ tons of zinc plating are required every 24 hours. From this point upward, savings become increasingly impressive as daily consumption increases.

FREEZING BOLTS

Shrinks Them For Easy Assembly

Bolts weighing 205 pounds are shrunk a fraction of an inch by dry ice to insure good fit in the assembly of the great 150,000-horsepower hydroelectric turbine-generators at Grand Coulee Dam in Washington.

The bolts are nearly six inches in diameter and two feet or more long. Too heavy and too cold to be lifted by hand, the bolts are lowered into position by a small hoist. After placement, the bolts return to normal temperature and expand to a perfect fit. Before installation the bolts are placed in dry ice for 12 to 16 hours.

STOP NUTS

Now Available in Anchor Type

Designed to provide vibration-proof fastenings for blind-mounting applications, as in removable plates used to cover hand holes, access and inspection openings, and for other blind-mount attachments, anchor nuts of the type manufactured by Elastic Stop Nut Corporation are permanently riveted to the inside of the structure. The bolts, which are inserted from the outside, pass first through the removable plate, thence through the structure into the stationary nuts.

These nuts are offered in a wide

range of size, material, and thread system, every nut incorporating the basic Elastic Stop self-locking feature, a fiber locking collar which is an integral part of each nut. This locking fiber prevents the bolt from becoming loose after it is installed in the nut, regardless of the severity of the vibration to which it is subjected. In such mountings, the bolts may be removed and replaced many times,

Vibration-proof—two types

the anchor nuts retaining their locking ability because of the resilient character of the fiber collar. It is claimed that the fiber of the collar, being softer than the metal of the screw, cannot damage the threads.

As with other Elastic Stop Nuts, when the end of the bolt enters the unthreaded collar, its passage is resisted, thus immediately and automatically eliminating all play between the threads of bolt and nut, and establishing contact of the load-carrying threads under pressure. Further turning and tightening of the bolt impresses a thread in the fiber collar, creating a moisture-tight seal around the bolt and maintaining the thread contact with a resilient grip. The braking action of the collar itself serves further to prevent any backing out of the screw.

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TOUGH: Industrial use shows bristles of nylon are at least three times as tough as those that grow on a hog.

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PRESSES

Hydraulically Operated, Smooth, Fast

To SIMPLIFY production problems, Colonial Broach Company's "Junior" presses have been designed to increase work-handling capacity. Smoother and faster than mechanically operated presses, the line of Junior presses designed for assembly, straightening, and so on, includes two hydraulically operated units rated at ½ and 1 ton capacities, both with 12 inch stroke.

The models are similar in design and construction with principal dimensions the same for both. Both are suitable for mounting in virtually any location—on benches or pedestals. While designed primarily for work on small parts, the large throat clearance (between ram and column) permits operations on large and bulky parts.

By the use of special coolant equipment, light broaching can be done on these machines. However, for such work Colonial "Senior" Presses are usually recommended since coolant equipment is a "built-in" feature of these units.

Control of the ram stroke is through a four-way valve, operated manually by a single-lever control, with the ram stopping at the bottom of the stroke or automatic return, and by the use of adjustable stops. The ram-operating cylinder is integral with the massive one-piece column of the machine for maximum rigidity. Ram speed down is 30 feet per minute, with return speed of 60 feet.

The hydraulic system includes an adjustable pressure relief valve so that the maximum ram pressure may be adjusted to any desired limit within the capacity of the machine. Thus ram pressures may be limited, if desired, to prevent damage of parts during assembly. Provision is made for the installation of a pressure gage on the column, for use in assembly work where exact press-fit tolerances are important. Thus equipped, the reading of the pressure gage during assembly will indicate the character of the fit, thereby serving as an inspection device.

Greater work-handling capacity

Autogiros Against Submarines

Convoy Duty Requires the Services of Aircraft With Peculiar Qualities for the Job in Hand

ALEXANDER KLEMIN
Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University

NEWSPAPER reports from London reveal what has been suspected for some time: the British are using catapult-launched single-seater fighters on board freighters as protection against air attack, employing small Hurricanes of relatively short range but with sufficient fire power successfully to attack a four-engined Focke-Wulf bomber. The pilots are specially trained and particularly courageous men. They need both qualities because the service is such a hazardous one. Suppose the pilot shoots off via the catapult and downs the enemy in the air, or the submarine by means of a depth charge. He cannot land on the deck of the freighter, so he has but two alternatives: To seek a land airport, hoping that his fuel supply will be sufficient, or else to "mush" into the water as near a ship as possible and save himself via life belt, as the airplane itself is sure to sink even if it does not turn over when alighting on the water. However skilled the pilots may be, however alert the surface vessels and air patrols of the British may be, casualties must occur. An airman bobbing about in the rough sea is a very small object to see, and the service must of necessity be hazardous, though thoroughly worth while.

Commander William A. Read, U.S.N.R., writing in the *United States Naval Institute Proceedings*, advocates another type of air escort for freighters or convoys; namely, the autogiro:

"If an aircraft type could be produced capable of operating from and to a short deck on the stern of a merchantman without requiring a catapult for take-off, or a stop for hoisting aboard by crane, and yet carry a military load of pilot, observer, radio, and depth charges, it would be possible to apply increasing offensive pressure against submarines. There is such a type in the rotary wing autogiro. . . . It should be possible today to build such a machine capable of fulfilling service requirements for convoy escort duty and capable of easily operating from and to a platform 100 by 50 feet or less."

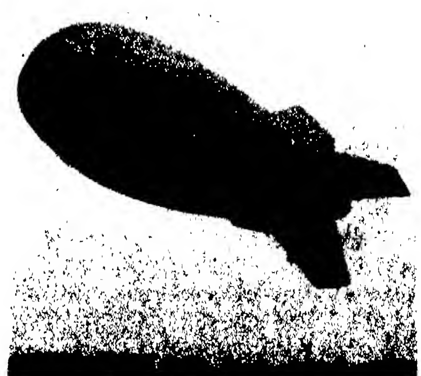
Commander Read's suggestion has great merit. Of course an autogiro could not tackle a Focke-Wulf bomber as readily as a Hurricane, but it could put up an excellent fight, and against submarines it would be *more* effective than the Hurricane. It will be noted also that the Commander advocates the giro as an offensive weapon against submarines more than against bombers. At any rate, the suggestion is thoroughly worth prospecting both by the British and ourselves. [This suggestion brings to the fore once again the similar plan for using autogiros in convoy work, put forth by Scientific American, and fully described in our issue of December 1939.—*The Editor.*]

BALLOONS

Factors in Design of these Effective Defenses

THAT our own War Department is convinced of the utility of the balloon is indicated by orders for 3000 balloons, said to be under present consideration, and the hundreds that have already been ordered.

A convincing demonstration of



Small balloon, showing catenary curtain and the attached bridle

barrage-balloon operation was recently given by Goodyear Tire and Rubber Company, at its private air station at Wingfoot Lake, Ohio, which served as a training base during World War I for balloon and blimp pilots. In actual practice the captive balloons are capable of rising to 7000 feet or more, with

The number of fins corresponds to the number of dividing lobes

the height of ascent roughly dependent on the size. Thus, the relatively small model, the Goodyear D-5, has a capacity of 30,000 cubic feet and a ceiling of 7000 feet, while the Goodyear Strato-Sentinel model, with 68,000 cubic feet capacity, rises to 15,000 feet. The reason that larger balloons can rise to a greater height is that there is a certain amount of dead weight in connections, valves, and other mechanisms which every model has to lift, no matter how restricted in size. Then, the weight of the fabric has to be supported, and the reserve of the lifting capacity supports the steel cable, which may be of small diameter but is heavy when thousands of feet of its length are in the air.

The lobes dividing the balloons' skin are employed for ease of construction, and because they make maintenance of form, after inflation with helium, somewhat easier. An important problem in the design of the balloons is stability. The air resistance of the balloons depends on the attitude they take relative to the wind, and this attitude or angle of attack must not be too great or the cable may part or tear away from the fabric. Hence the provision of the large fins at the rear.

The air-drag of the balloon and the buoyancy which carries the weight of the cable create appreciable forces on the holding-down cable and these forces cannot be taken up at a single point on the surface of the bag. Hence the peculiar design of scalloped fabric, or curtain, sometimes referred to as a catenary curtain, on the sides of some of the balloons, from which the flying bridle is suspended.—*A. K.*

AIR SAFETY

Rules Laid Down By the CAB

THERE have been surprisingly few accidents in the Civilian Pilot Training Program, but instructors and students should always be on the alert and never relax vigilance or adherence to good flying practice. The Civil Aeronautics Board has just issued some splendid, concise safety rules. They are:

1. Know and Obey Civil Air Traffic Regulations.
2. Believe Your Instructor.
3. Fasten Your Seat Belt.
4. Check Fuel Supply before Taking-Off.
5. Check Controls Before Taking Off.
6. Be on the Alert for Other Traffic.
7. Climb Sensibly.
8. Land Straight Ahead if Engine Fails at Low Altitude.
9. Avoid Flat Turns.
10. Maintain More Than Just Enough Flying Speed.
11. Never Stretch Your Glide.
12. Turn Back or Land When Weather is Doubtful.
13. Go Round Again if Your Approach is too High.—*A. K.*

• • •

FLIGHT: For every hundred miles flown by transoceanic Clippers on schedule with mail, passengers, and express, more than ten miles are flown in preparatory, test, and other non-schedule flights.

• • •

PLANE CONDITIONING

Cools in Summer, Warms in Winter

A NEW type of air conditioner, which should make passenger cabins completely comfortable under either extreme of temperature, has been placed in service by United Air Lines. Built by the O. E. Wendt Company and Delco, of General Motors, the "comfortizer," as it has been called, is mounted as

a unit on a truck, and is used for air conditioning the plane while on the ground. In contrast with other means of cooling previously used on airplanes, the new unit employs ice. Water from the ice is atomized and air is drawn through the resultant vapor before being pumped into the cabin. With a capacity of 15,000 cubic feet of ice-cooled air per minute, the unit will reduce cabin temperature from 100 to 80 degrees in 20 minutes. For heating, a standard oil-burning furnace of the type used in a seven-room house—capacity 250,000 B.T.U's per hour—is employed.—*A. K.*

CO-OPERATION

Several Plants to Build One Type of Plane

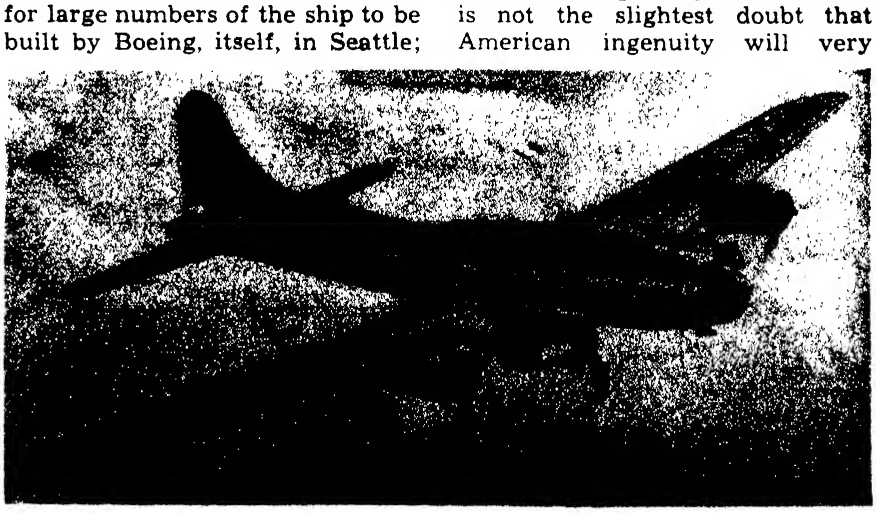
AGAIN and again we have heard well-informed opinion to the effect that, if the R.A.F. had 2000 or 3000 powerful, long-distance bombers, and the capacity to maintain them in operation, the potential devastating attacks then possible on Western Germany would shorten the war. As proof that this opinion is shared by the Army Air Corps, or whoever is responsible for our plane production, orders have been placed for manufacturing large quantities of the new four-engined Boeing B-17E shown in one of our illustrations. Aerodynamically, nothing could be more trim than this huge machine, described by the War Department as bigger and more deadly than any of its predecessors, with its machine guns, cannon, power-operated gun turrets, and enormous engines. While the B-17E was designed and built by Boeing Aircraft Company, it is encouraging to learn that a co-operative production program calls for large numbers of the ship to be built by Boeing, itself, in Seattle; Douglas Aircraft, at its new plant in Long Beach, California; and Vega Aircraft at Burbank, California. A special inter-plant committee is busily at work ironing out difficulties that are bound to occur, and exchanging wrinkles on speedy production methods.—*A. K.*

MOBILE

Surfaces Developed for Emergency Airports

THREE types of mobile landing fields have been developed by the U.S. Corps of Engineers for heavy bombers, light bombers, and pursuit ships, respectively. Experimental work was started late in 1939, with tests at Fort Belvoir and Langley Field, Virginia. The test program brought out certain characteristics which should be found in any "mat," as it is called, which is to be used for a mobile landing field. These include strength, continuity, speed of laying, speed of production and rehabilitation, low cost, ease of camouflage, skid-proofing, life, wear on tires, and so on.

Three materials found suitable for use as an emergency landing mat were steel plank, Irving grid with slip-ring connectors, and rod-and-bar grid with wedge connectors. While the steel plank presented a more satisfactory surface, it was slippery when muddy, and difficult to camouflage, but improvements have been made in coupling the planks, in camouflaging with paints, and raised buttons have eliminated skidding. Although some of the grids lacked continuity, a very promising grid type mat is now available, but it costs more than the steel planks and takes longer to produce. There is not the slightest doubt that American ingenuity will very



Bigger, more deadly than its predecessors

shortly produce a suitable mat, making the whole surface of the globe a conceivable flying field for our Air Corps—an immense tactical advantage.—*A. K.*

TRAILER-CRANE

Aids in Handling Aircraft Engines

AVIATION becomes less romantic, more practical, and stoops to labor-saving devices. The Boeing School of Aeronautics, for example, has developed a combination trailer-crane which is most useful around an airport for transporting and lifting heavy aircraft engines. The trailer has a capacity of two tons; the crane a capacity of one ton. Over-all length of the trailer is 12 feet; outside width is eight feet; over-all height is 14 feet. Vacuum booster-brakes in the trailer are controlled from the steering column of the towing car. When not in use, legs of the crane lie flat on the trailer.—*A. K.*

Boeing's aircraft crane

AERONAUTIC DECIBELS

A Handy Noise Meter for Aircraft Use

PHYSICAL measurements of electric current, flow of water, speed of air, and many other quantities have long lost their mysterious character but, when it comes to the measurement of noise, matters are somewhat less well understood. Noise is an air wave; the greater the noise, the greater the intensity or pressure of the wave. All that the decibel meter has to do is catch the pressure wave in a microphone not dissimilar to a telephone microphone, amplify the indication which is brought about by the fact that the pressure wave modulates an electric circuit so that a current is produced or modified, and transmit the amplified signal to an electrical indicating instrument.

Measuring airplane noise level

Of course, in actual application, there is a good deal more to the instrument than mere bare words indicate and, in the early days, measuring noise involved a whole laboratory! Now General Electric announces a very handy portable decibel meter which weighs only 19 pounds, has a decibel range of 24 to 120 decibels (roughly covering sounds from the rustle of leaves to the scream of a factory whistle), and is small enough to be carried easily—in the cockpit of a small airplane, for example, as shown in one of our photographs.—*A. K.*

TRAINING

Progress of the Civilian Pilot Program

AT THE Aeronautical Section Meeting of the National Safety Council a group of papers was devoted to the discussion of safety in the C.P.T. program. Early criticisms of the C.P.T. have disappeared because the system has given the nation a splendid source of Army and Navy pilots.

Today, between seven and eight thousand C.P.T. students and instructors are in the Army or Navy air services, or are training groups, and about 22 percent of the new cadets in Army or Navy air services are graduates of C.P.T. With courses offered in 709 colleges and 221 non-college units, more than 10,000 men have completed the primary training course, and several thousand the secondary course. Other valuable derivatives of the Civilian Pilot Training program have been the reduction in insurance premiums for private flying training, and a much better understanding of what constitutes safety in private flight training.—*A. K.*

Conducted by JACOB DESCHIN, A.R.P.S.

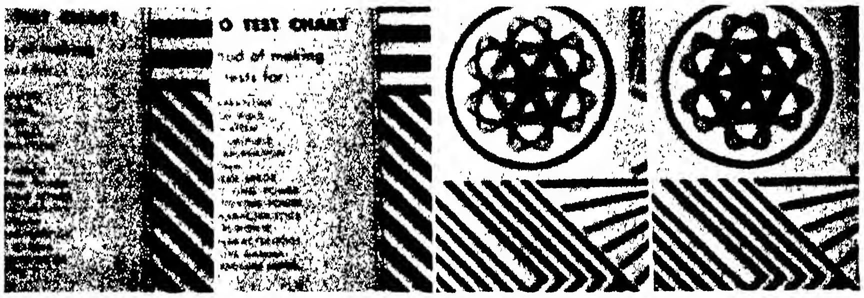
Image Sharpness

When you say your camera does not make sharp pictures, you can mean any one or more of a number of different things. Let us check over the things that might interfere with getting consistently sharp images in your negatives and your prints. Only then, and this will be the case only if our tests have been accurate, may we say that the lens simply is not sharp; that is, its resolving power is so low that it is inherently incapable of rendering a sharp image.

First of all, we must set aside all factors of a mechanical nature, such as failure on the part of the photographer to focus the subject properly; inability to hold the camera steady during the exposure, thus causing camera shake or movement; the use of a shutter speed too slow to stop the motion of an active subject, and so on. We are to take all these things for granted.

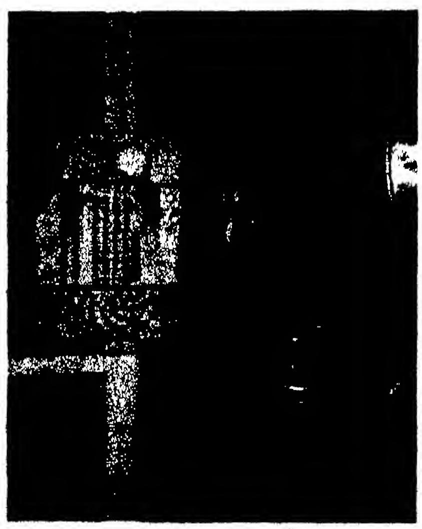
One of our readers recently wrote to say that his lens does not give a sharp picture even when he stops the diaphragm way down. Thereupon, he hit on one of the popular false notions, namely, that a very small stop will always give a sharper picture than a large one. However, this is too sweeping a statement to make concerning all lenses, because the situation differs with different lenses. With some lenses the very smallest stops will give an unsharp picture, at least not as sharp as one a stop or two larger. The best way to find out what your lens does at various stops is to give it a thorough test by setting up a test chart, or something similar, having fine lines and printing or writing on it, illuminating the chart evenly, as in copying, and then making a series of exposures at the different lens openings, compensating for exposure as you go along. After you have made the test and made prints from the several negatives, you will know which lens stops to favor and which to avoid, if you possibly can, under operating conditions.

In a recent test of two lenses, we found that in the case of a semi-telephoto lens, the largest stop of $f/4.8$ gave the poorest image sharpness, while the smallest stop of $f/32$ gave the sharpest. As a matter of fact, the only really sharp images were those taken at $f/22$ and $f/32$. The results are reproduced in Figure 1 (wide open, $f/4.8$) and Figure 2 (stop $f/32$). In the test of the other lens, the wide-open stop of $f/2.9$ was definitely soft or unsharp; satisfactory sharpness was not apparent until the stop $f/8$ was used. Equally good results were found at stops $f/11$, $f/16$ and $f/22$, but fell off again at stop $f/32$. When using this lens, therefore, we try to use only the stops from $f/8$ to $f/22$, employing the larger stops only when absolutely necessary.



Left to right: **Figure 1, wide open at $f/4.8$; Figure 2, at $f/32$, both semi-telephoto lens. Figure 3, wide open; Figure 4, at $f/22$, other lens**

In testing the results, we enlarged the test negatives 20 diameters. This was the supreme test, of course, and it may be argued that such large enlargements are not often made. However, the prints tell the story better than normal enlargements would have. In this connection, image sharpness may be relative, depending on how big an enlargement you intend to make. An enlargement of five diameters, for example, may be perfectly satisfactory as to sharpness even when some of the stops are used



Camera set-up for checking lens sharpness with chart

that were deemed unsatisfactory when "blown up" 20 times.

Unless fine-grain film is used and this developed in a fine-grain developer, another factor tending to unsharp results is coarse grain. This again will depend on the magnitude of the enlargement. A small enlargement of the full negative may not show it, but a greater one would. Other factors in this connection are over-exposure and over-development, both of which will cause grain in the enlargement and therefore image unsharpness.

How Much Diffusion?

There is diffusion . . . and diffusion. It is a method calling for an understanding of the fitness of things. What to diffuse and what not to diffuse depends on the subject and the effect wanted. But, aside from this, there is also the degree of diffusion that is, according to the majority opinion, permissible in any photograph.

As a lark the other day, we attempted to find what this maximum

Figure 1

of diffusion might be, and where it is best to stop for generally acceptable results. For the purpose, we employed a number of metal screens of various degrees of fineness, or coarseness. The screen was made up of many apertures in a regular, evenly spaced pattern, like an engraver's screen. After projecting the image on the easel, we interposed the coarsest of the screens between lens and easel, holding the screen fairly close to the lens during the total exposure. We then interposed for successive prints each of the other screens, the coarseness used being successively finer. The finer the screen, the greater was the diffusion.

The greater the diffusion, the more exposure was required because the intensity of the light became weaker in each case. In addition, the tone scale was spread out more and more, thereby necessitating the use of paper having a harder contrast. The maximum of diffusion, in our opinion not

Figure 2

desirable because it comes too near a simulation of an out-of-focus image, was obtained with a screen four times as fine as the coarsest. The result is shown in Figure 2; Figure 1 is the reproduction of a print made through the coarsest of the screens used.

To Retouch, or Not

"The technique of portrait retouching," writes Mrs. K. C. Anderson, in a letter to *The Agfa Diamond*, publication of Agfa Ansco, "has got to change along with lighting, style, and general changes in photography. I personally think that the old school of retouching is passing and any photographer who insists on an 'overall' job is not keeping up with the modern trend. Such terms as blending, building, stippling, and modeling are only valuable in retouching amateur portrait work where there is poor, unbalanced lighting. . . . It is a fact that retouchers generally have been slow to see the new trend toward realism in portraiture and they still retouch negatives the way they did 12 years ago, removing lines of character and personality from the face."

Bravo, Mrs. Anderson! These are exactly our sentiments, too.

Slide Continuity

You've picked the 100 best Kodachrome slides in your collection. You've classified them according to type of subject: flowers, street scenes, beach scenes, landscapes, sunsets, and so on. Your family or a group of friends have come in great anticipation to see them projected. For a while, everyone "oh's" and "ah's" at some of the fine color impressions you have caught. After a time, there is only an occasional "oh" from some polite guest, and you sense a lag in interest. In the semi-darkness you may even have had the disheartening experience of spying someone dozing.

What is the matter? The slides seem to be good, the color reproduction fine. Well, for one thing, the attention of an audience—and it is still an audience, even if it consists of

OVER $1100 IN PRIZES
36 CHANCES TO WIN

Sixth Annual
SCIENTIFIC AMERICAN
AMATEUR PHOTOGRAPHY CONTEST

POPULARITY of the divisional method of judging photographs in the Scientific American Annual Contests, as determined by the enthusiastic response in past years, has been so great that the method is once more being used for the Sixth Annual Contest. In each of the divisions listed below there will be awarded seven major prizes and five honorable mention awards, a total of 36 prizes in all.

Please read the rules carefully and abide by them. Note particularly Rule 6, under which any contestant may enter a total of six prints, but no more than two in any single division.

Divisions In Which Prints May Be Entered

Division 1. Human interest, including camera studies of people, animals and so on. Portraits will be grouped in this division.

Division 2. Landscapes, including all scenic views, sea scapes, and so on.

Division 3. Action, including all types of photographs in which action is the predominating feature.

THE PRIZES

1st. Three $125 LONGINES, Pres. Harrison Model, Solid Gold, Men's Wrist Watches.

2nd. Three $90 LONGINES, Presentation Model, Solid Gold, Men's Wrist Watches.

3rd. Three Intercontinental Marketing Corporation PHOTRIX "22" Enlargers, complete, less lens. (List price $54.)

4th. Three Burleigh Books FOTH-DERBY Cameras, with built-in coupled range finders. (List price $34.75.)

5th. Three WESTON No. 715 Exposure Meters. (List price $24.)

6th. Three ABBEY Vimo Flash Guns. (List price $13.75.)

7th. Three Raygram LEE Timers. (List price $12.50.)

Five Honorable Mention Awards, each to be a new or renewal subscription to Scientific American for one year.

Address all Entries to

Photograph Contest Editor, Scientific American

24 West 40th Street New York, N. Y.

Rules of the Contest

1. The groups will be judged independently on the basis of pictorial appeal and technical excellence. The decision of the judges will be final. In case of a tie for any prize, duplicate prizes will be awarded to the tying contestants.

2. Prints must not be smaller than 5 by 7 or larger than 11 by 14 inches. *All prints must be mounted*, otherwise they will be returned immediately.

3. Photographs must be packed properly to protect them during transportation.

4. Non-winning entries will be returned only if sufficient postage is included when the prints are submitted.

5. Each entry *must* have the following data written on the back of the mount: Name and address of contestant, type of camera, and film, enlarger, and paper used.

6. Contestants may submit no more than two prints in each group, but may enter any or all groups. In no case, however, will more than one award be given to any individual contestant.

7. Prints must be in black and white or monotone. Color photographs are not eligible.

8. Prize-winning photographs will become the property of Scientific American, to be used in any manner at the discretion of the publisher.

9. Scientific American reserves the right to purchase, at regular rates, any non-winning entry.

10. No entries will be considered from professional photographers.

11. All entries in this contest must be in the hands of the judges by December 1, 1941. Results will be announced in our issue dated February, 1942.

12. The contest is open to all residents of the Western Hemisphere who are not in the employ of Scientific American.

13. In fairness to all contestants, failure to comply with any of the above rules will result in automatic disqualification.

THE JUDGES:

McClelland Barclay
Artist

Ivan Dmitri
Artist and photographer

T. J. Maloney
Editor of U. S. Camera

Robert Yarnall Richie
Photographer

only two or three persons—has to be lured. Exhibiting a catalogue, however beautiful its individual parts may be, will not hold an audience for long. There must be some sort of interesting progression, or continuity, as the movie folk call it. If you can describe an incident with your slides, that is one good way. An easier method is to assemble a group of slides that describe a locale or a people. Even flowers can tell a story by grouping different specimens of the same flower, for example. Whatever plan you adopt, and this naturally will be governed by the type of slides in your collection, segregate the slides into small groups instead of projecting individual ones haphazardly. In addition, a line of chatter will help and record music to suit the subject, played softly, will supply a fine background of atmosphere. In short, since you're giving a show, make it a show and not a salesman's demonstration of his wares.

Adjusting Temperature

THE necessity for temperature accuracy in development is taken for granted, particularly in the case of fine-grain processing. The method often employed is to test the temperature in the bottle. For greatest accuracy, however, it is suggested that the solution be poured into the tank or developing tray and tested there. For adjustment up or down, place the tank in an empty tray, pour the developer into the tank and then allow water to run into the tray, hot or cold, whichever is required.

Let Them Pose Themselves

WE DIDN'T have very much to do with posing the lads on this old scow scaffold. "Mister, take our picture," they yelled, and up they went as we nodded assent. Two of them went straight to the top, the others preferred a midway position. The lad on the bottom really saved the day

"Mister, Take Our Picture?"

in the matter of composition. We asked him to come down two steps and as he did, he assumed the pose you see. It was a happily chosen pose because it brought the needed weight to the lower right hand corner of the frame.

In situations of this sort, with active children such as these, the more you fuss posing them the less success you have. Try letting them arrange themselves; rather frequently, the result will be better than you anticipated.

Color Horizon

EVEN a dull day, with sky heavily overcast, may offer a good subject for color photography. All late afternoon there gleamed on the horizon a long, thin ribbon of golden, gleaming light, which grew more mellow as the afternoon wore on towards sunset. It was too beautiful to miss a color record, but you couldn't simply shoot the horizon; you had to have something to fill the predominant expanse of sky. Part of an old wrecked ship, therefore, was used as a frame to occupy the sky and bring the attention to the ribbon of light separating the horizon and the sea of heavy clouds. We took a number in black and white as well as in color, the illustration showing one of the arrangements. In color, the exposure was $f/9$ at 1/20.

"Storm Brewing"

Contest Prizes

WHEN the rules and prizes for the Sixth Annual Scientific American Amateur Photography Contest were first published, we had already placed orders for the prizes, had received many of them. First prize watches, however, were not delivered when ordered. Now we find that, due to war conditions, it is impossible to obtain the Longines Coronation Model watches originally offered. Hence we have substituted, as the first prize in each division, a Longines President Harrison Model man's wrist watch,

valued at $125. This watch is as high grade in every respect as the Coronation Model, lists at the same price.

We hope that this change in the prize offer, made necessary by conditions beyond our control, will be equally acceptable to all contestants.

Aid to Allies

Formation of the Photo Arts Committee for War Relief to the Allies, is announced by Albert Greenfield, of New York City, the committee's Executive Secretary. The committee, formed for the purpose of putting into immediate application President Roosevelt's appeal for all aid to the countries battling the Nazi war machine, is sponsored by many leaders in the photographic industry.

"In order to make the campaign as effective as possible," states Mr. Greenfield, "the photographic industry has been divided as follows, with representatives of each group on the sponsoring committee: photographic manufacturers, distributors, dealers, editors, publications, camera clubs, societies, press photographers, photo finishers, photographic schools, commercial photographers, and photographic models."

Readers of Scientific American who have suggestions to make, are urged to write to Mr. Greenfield at national headquarters of the committee, 331 Madison Avenue, New York City. Those wishing to send contributions may mail checks or money orders drawn to Photo Arts Committee for War Relief to the Allies; these should be sent to the national headquarters.

New Blackout Exposures

Since the publication of our article on the Wabash Blackout Superflash in the October issue, the company has made a change in the composition of the dye-lacquer solution with which the bulbs are coated. The resulting red glow is much weaker than was the case with the first bulbs, making it more useful than ever in the fields for which it was designed. The exposures are necessarily longer. Wabash suggests the following for "black" bulbs now on the market:

1/25th second, up to 15 feet........ f/5.6
1/50th second, up to 15 feet........ f/4.5
1/100th second, up to 12 feet...... f/3.5

• • •

WHAT'S NEW

In Photographic Equipment

Precision Enlarger with Power-Cooled Lamphouse Assembly: B Assembly, for large negatives, now has Power-Cooled Lamphouse Assembly B designed so that stream of cool air is directed through lower portion of lamphouse to circulate between surfaces of heat absorbing glass and opal diffusing glass. Air current does not circulate directly above negative area, thereby eliminating possibility of dust being deposited on negative holder. Because of temperature control, user may substitute higher wattage No. 213 lamp for regularly supplied No. 212, increasing speed of enlarger about two and one-half times. Control Box, supplied with enlarger, arranged so that cooling mechanism and enlarger lamp may be operated independently of each other. Sheet film, film pack film, plates and individual frames of roll film up to and including 4 by 5½

inches accommodated in Combination Negative Carrier B. Adjustable Negative Mask B permits masking off any desired portion of negative. Prints 11 by 14 inches on baseboard; entire head may be turned 180 degrees around column for projecting on floor or swung and locked at any position from vertical to horizontal for projecting to wall.

Model "K" M.C.M. Photometer ($5.85): Combined photometer and densitometer. Third scale (logarithmic) added to read directly in absolute densities. New scale converts Haynes Photometer into projection densitometer; can be used to measure fog level of negatives, balance densities of color separation negatives, estimate gamma to which negatives are being developed, and so on.

Panatech Darkroom Apron: Available in black or white. Made of bombazine cloth, with heavy calendered rubber coating. Measures 36 inches long, 24 inches wide. Drip cuff at bottom held by snap-buttons, for draining. Neck strap, waist strap of heavier quality web.

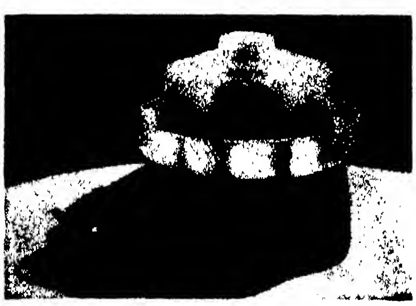
Lee Strobo Speed Lamps: Designed for ultra-high-speed photography. Speed approximately 1/30,000 of a second. Cool light. Allows maximum image detail, extreme penetration of light, complete subject control. Almost all camera shutters easily synchronized with lamp, no readjustment of shutter tripper necessary when changing from flash bulb to Lee

Speed Lamp. Will work independently of shutter action. Small apertures permissible with consequent increased depth of field. Consists of complete power supply unit which can readily be assembled by anyone with only a screwdriver, pliers, and soldering iron; complete plans and illustrations supplied. Offered in three models: A-1 consists of one lamp unit complete with one 15-foot special extension cord and one flash lamp tube for 115-volt, 60-cycle use ($125); B-1 consists of adapter unit in identical metal cabinet to A-1; converts A-1 unit to three-lamp unit, C-1, at any time ($150); C-1 consists of three-lamp unit complete with three 20-foot special extension cords and three flash lamp tubes, 115-volt, 60-cycle ($250).

New Midget Flash Price: The price of the Wabash Superflash Midget bulb has been reduced from 15 cents to 11 cents, according to an announcement by the company.

Brownie Reflex, Synchro Model; Brownie Flasholder: New model operates like old one when used outdoors, but is convertible to flash camera by attaching Brownie Flasholder (battery case, polished reflector, lamp socket). Flasholder designed for synchronized flash with Mazda SM (Speed Midget) Photoflash lamp. Ejector knob on back of reflector. Synchronizing switch within shutter preadjusted at factory so peak intensity of SM lamp occurs when shutter is fully opened. No further adjustments necessary.

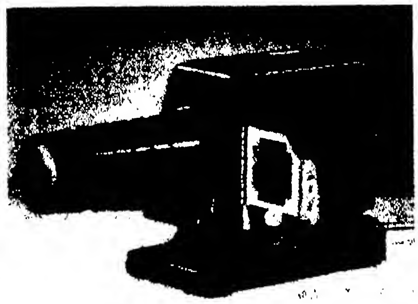
C.S.I. Film Tank Agitator ($3.35, complete): All-electric, featuring non-directional motion parallel to plane of rotation. Direction of circulatory motion changes every one



and one-half seconds, thus keeping fresh developer in contact with film at all times. Wertex plastic case. Tenite plastic pan. Capacity, two-quart tank, or less.

Quixet: Magnetic movie titler, for black and white and Kodachrome titles. Made of plastic. "Alnico" magnets, requiring no adhesives or pins, hold firmly to any iron or steel surface through paint, lacquer, or enamel. Can "pull" through paper, cloth, photoprints, permitting use of unusual backgrounds. Can be arranged in curves, angles, circles, as well as in straight lines. Guaranteed to retain magnetic properties for ten years. Letters ⅝ of an inch high; also available in 1 and 1½-inch size letters. Come in sets of white letters with black panel and red letters with blue or green panel, in regular or deluxe sets.

Kodaslide Projector, Model 2A: Available with either 5-inch, $f/3.5$ lens, or 7½-inch, $f/4.5$ lens. Replaces Model 2. Carries 150-watt lamp. New Projecto Case, in addition to Com-



bination Case for projector, lens, and file boxes, carries, in addition to latter features, folding leg stand which, when in use, provides convenient projection stand and extra shelf for 2 by 2-inch slide boxes.

Kodak Advance Enlarger, Model 2: Complete with baseboard and 98mm, $f/11$ projection lens mounted in removable lens board. Standard equipment includes friction-drive micro-focusing mechanism. New negative carrier designed to accept negatives in roll or uncut strip as well as individual negatives. Negative carrier of strong black molded material; frame holds two sheets of glass and one metal mask, latter making possible to enlarge 3 3/16 by 4½-inch sections of 3¼ by 5½-inch or 4 by 5-inch negatives. Set of metal masks, 35mm to 3¼ by 4¼ inches, available to fit negative carrier. Mask assembly held in close contact by two spring clips slipping over top sheet of glass. Removable plush-lined light guards clip into each end of negative holder. Film strip may be pulled through holder to selected negative without removing holder from enlarger.

Minicolor Pocket Folders, Cases, Album: Designed for display and storing of Minicolor prints size 2x (2¼ by 3¼ inches). Folder, of maroon leather-like material—for one, two or three prints—measures 2⅝ by 3½ inches closed, fitting into handbag or pocket. Prints held firmly in position by slipping corners under cellulose acetate corner pieces. Cases, holding one, two or three prints, similar in style to Pocket Folders, but designed with fold-over flap and glove-button fastener. Wire-bound Minicolor Print Protecto Album, holding up to 24 2x prints, has six transparent envelopes with gummed leaves inside to hold prints mounted back to back.

YOUR FIREARMS and FISHING TACKLE

Conducted by A. D. RATHBONE, IV

INTEREST IN FIREARMS *is traditional with American men; fishing tackle is a requisite of one of the world's oldest occupations. Scientific development of guns and tackle, in the use of which millions yearly find sport and recreation, fathers this monthly department which welcomes correspondence from readers.*

You Pull the Trigger . . .

WHEN YOU pull the trigger of your gun, you've started something—and in view of the enormity of the force you've set in motion, you will want to be sure that certain factors are properly under control—or else! It goes without saying that you'll have the gun pointed at something you *want* to hit. But how about other things? Is the barrel free from *all* obstructions, including a heavy coating of protective grease? Was your

Photo by Lt. Kenneth Romaine
The shooter was lucky!

gun built to absorb the shock of the gas explosion that takes place when the fulminate of mercury in the primer ignites the gas-forming powder in the cartridge or shell?

Today's is a progressive-burning powder, which made possible the origin of high-velocity load development some 20 years ago, and it produces a gas that expands in volume to many times that of the charge of powder. In less than the flick of an eye-lash after ignition, this constantly increasing gas force tries to expand in all directions, and if the cartridge chamber of a gun were not strong enough, it would be blown to bits. Because the chamber is husky, because least resistance is offered by the light-weight bullet (or pellets, in a shotgun), the bullet is forced from its shell and into the barrel. Once the inertia of the bullet is overcome, and as this progressive-burning powder continues to burn and form more of the powerful gas, the slug—or scatter-gun shot—is boosted toward the muzzle and on its way.

As an example of variance in breech pressure derived from powder of former days and that of today, Damascus shotgun barrels were designed to handle shells that developed average pressures of about 5000 pounds per square inch. Modern high-velocity shot shell loads nearly double this pressure. The Remington Nitro Express load exerts its pressure at the terrific rate of about 36,000,000 pounds per square inch per second. Of course, this pressure build-up does not utilize much time—neither does the actual explosion of a one-ton demolition bomb—but it's long enough to raise hob with anything but a modern shotgun barrel, including the hand that is supporting it.

The standard .38 caliber S. & W. revolver cartridge develops approximately 16,000 pounds per square inch breech or chamber pressure. The cylinders of modern, well-known revolver barrels are constructed of chrome-nickel-steel alloy and specially heat-treated to resist such high pressure. In order to obtain workability, however, revolver *barrels* are not made of such alloy steel, nor are they heat-treated, for by the time the bullet enters the barrel, pressures are greatly reduced—that's how fast this whole process works!

The bulging of revolver barrels is invariably due to faulty ammunition. The cause can be either deterioration of the powder charge or priming charge, or the mere absence or near absence of powder in a cartridge. When one bullet stops in the barrel, and another is fired behind it (which is what happened to the gun in one of our illustrations), there is no leak-

They couldn't take it

age of air between them. Something must let go. Usually the barrel splits at its weakest point, often the point of stamping. Sometimes it doesn't split, but stretches sufficiently to allow the pressure between the two cartridges to escape one way or the other.

"Big-Time" stuff, this modern ammunition!

For Defense Training

THOUSANDS of men have associated themselves with one or another form of civilian defense units. This influx of gunners and would-be gunners to the nation's revolver and rifle ranges, skeet and trap fields, has created an additional drain on the already limited supply of shotguns, small caliber rifles, revolvers, and

Targo gun

their respective ammunitions. Another problem is the expense of arms, shells, and cartridges.

In past issues we've pointed out possible solutions to this puzzle, and here's another. The Targo Gun, introduced by O. F. Mossberg & Sons, Inc., about a year ago, can be made to serve the dual purpose of providing .22-caliber rifle practice and aerial gunning practice on miniature clay targets, using .22-caliber shot shells for the latter operation.

The Targo gun is equipped with a 5-inch section of rifled .22-caliber barrel which is interchangeable with the Targo Tube, an 8-inch barrel section which is attached when firing the .22 scatter-shot shells. For this type of gunnery, the 14-ounce trap is fastened to the barrel ahead of the forearm so the gunner may release his own targets with his left fore-finger, or they may be thrown by another

Targo barrels

person with a Targo handtrap. Targets are one-half normal size, break on impact of the tiny shot pellets up to 50 feet.

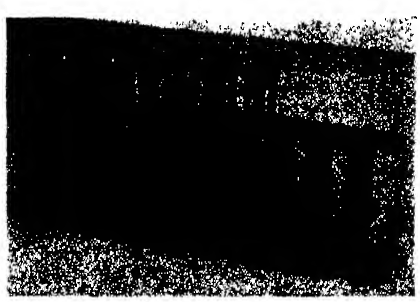
We've found the 5-inch rifled section of barrel provides remarkable accuracy in .22-caliber rifle fire. The inexpensiveness of ammunition and targets, the low cost of the gun itself, and the fact that it can be quickly adapted to either of two uses make the Targo outfit something to conjure with. Would you like a folder?

What of Sporting Arms?

A QUESTION that has doubtless come to the minds of many gun owners is: What effect have national defense efforts had on the production of sporting arms and ammunition? A recent survey, by correspondence, indicates that while price increases may be expected under present conditions, there will be little shortage of the more popular models of guns, shells, and cartridges for the next few months. Next year, however, may be different. The tooling up of arms and ammunition plants for defense requirements has necessitated utilization of every available machine unit, every ounce of man-power, and the temporary relegation to the background of less-widely-used sporting arms and ammunition. Adoption, months ago, of a far-sighted policy of heavy production and larger-than-normal stocking by manufacturers, distributors, and dealers will doubtless allay any serious shortages in the immediate future. Should present demands on American arms manufacturers increase, John Q. Huntsman and Aloysius X. Marksman can make up their minds that any resultant curtailment on their gunning activities will be just one more little sacrifice on their parts toward the furtherance of national defense.

Cartridge Carrier

A NEW shell pack, constructed of high quality rubber in red, black, and walnut-brown colors is offered by Mershon Company, Inc. The "Sure Grip" protects the lead, holds 10



cartridges of any high-powered caliber, fastens to belt with two-inch loop running full length of pack. Cartridges do not rattle or work loose; drain holes permit sand, dust, or other foreign elements to fall out of the bottom.

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Maker—Advanced."

No machine is needed for grinding and polishing telescope mirrors, and only a minority of amateur telescope makers use machines, since one's two hands are a good machine. Nevertheless, among advanced mirror makers who finally tire of pushing glass by hand, or who, following Yankee tradition, need less than half an excuse to build a machine of any kind, machines are becoming more and more common. No machine has been copied so often as the one described by Hindle in the present (fourth) edition of "Amateur Telescope Making." This machine—now firmly established—is a pronounced success. Such a machine was built by Cyril G. Wates, 7718 Jasper Ave., Edmonton, Alberta, Canada, and described in the January, 1941, number of *The Journal of the Royal Astronomical Society of Canada,* 198 College St., Toronto, Ontario, a journal which, by the way, is entirely amateur even if "royal," and the following is a slight adaptation from that description.

"The machine shown in Figure 1 was constructed almost entirely of junk parts and the cost was surprisingly low. The framework is built of 2" x 2½" x ¼" angle-iron. The motor *F* is a second-hand washing-machine motor. The main flywheel came from an ancient treadle-drive dental engine.

"The main drive shaft *G* is ¾" steel shafting, but it would be better to use 1" shaft, as the lighter shaft has some tendency to whip at the center. The upright shaft *H* is driven by a worm gear from an old car. Shaft *J* is driven by a bevel-gear taken from a discarded differential.

"With regard to the bearings, of which there are six, it was found that standard pillow blocks would run into quite a sum of money, so a makeshift was devised consisting of short sections of 2" pipe welded to bases of heavy bar iron. The various shafts were centered in these pipes and babbitted, grease-cups being inserted in the four upright bearings, and oil-holes bored in the horizontal ones. All speeds being low, these bearings should run without appreciable wear for a very long time.

"The working platform *D* consists of two layers of ¾" board, glued and screwed and then given several coats of paint. It is fastened to a flange at the upper end of the 3" pipe *E*. At the lower end of *E* is a short bolt running in a plain bearing. This bolt is fastened into a plug of oak secured to *E* by means of wood-screws. The platform turns very slowly, being driven from the shaft *H* by means of a bicycle chain and sprockets.

"At the tops of the upright shafts are adjustable cranks, *K* and *L*, which control the motion of the 'alligator.' The elaborate construction of the right-hand crank is an unnecessary refinement. It can be seen that the crankpin *L* is controlled by a long screw with a ratchet-wheel *M* at one end. This ratchet encounters the double pawl *N* at each revolution, thus providing a continuous variation in the length of the swing.

"The alligator, *A*, is a framework of 1" x ½" channel-iron, welded together. The alligator is built around a square frame which embraces the mirror. Four lengths of ½" pipe are welded into holes in the corners of this frame. Sliding in these pipes are ½" steel rods, one of which is seen plainly at *B*. The rods are tipped with rubber buffers—carried by most hardware stores for walking sticks. The push-rods are locked in any positions by means of set-screws threaded into the alligator.

"The crankpin *K* drives the alligator from any one of several holes in the center brace of the framework, permitting adjustment for overhang, as in the Hindle design.

"Two adjustable guides are seen in the photograph at *P, P*. These prevent rocking of the alligator. Only one guide is necessary and the right-hand one has now been removed. The contact between the alligator and the guide is the one place where, in spite of lubrication, squeaking occurs. This was overcome by fastening a leather strap on top of the guide. The weight of the alligator should not rest on the guide but on the adjustable collars on the crankpins.

"Crankpin *L* works in a long slot formed by two facing angle-irons at that end of the alligator. Therefore, crankpin *K* provides the drive, while crankpin *L* gives the swing.

"On top of platform *D* is a simple drip-pan, made by soldering a strip of galvanized iron to a disk of the same material. The tool (or mirror) is held in place, slightly off center, by blocks secured to the platform by wood-screws. A sheet of paper under the blocks makes cleaning-up a very simple job.

"When in operation, the push-rods move the mirror in a series of elliptical strokes over the surface of the tool, these ellipses traveling from side to side under control of crankpin *L* in its slot. Obviously, the length of stroke and the swing can be changed as desired, from a very long stroke for roughing out the curve, to a short stroke for bringing the disks into spherical contact.

"The most important feature of the Hindle machine has not yet been mentioned: the method of rotating the mirror, *C*, between strokes. This motion is provided by adjusting the push-rods so that there is a clearance of about ¼" between the rubber buffers and the edge of the disk. This

Figure 1: **The Hindle type machine, as built by Wates, of Canada**

clearance means that, at the commencement of each stroke, one of the buffers will touch the mirror before the other, thus giving it a slight turning movement. This action is similar to what mechanics call a continuous ratchet.

"I wish to call attention to an error in the construction of this machine as pictured. A study of the various gears shows that the mirror turns in the same direction as the tool. To correct this condition, the shaft *G* with its

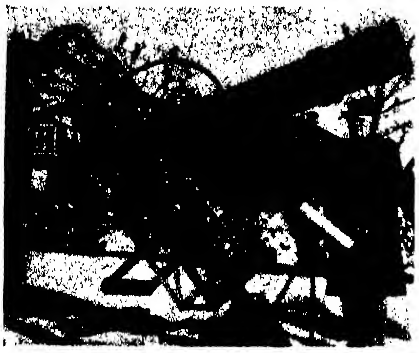


Figure 2: **Wates, 12½", & 4" RFT**

worm should be placed on the other side of the shaft *H*. I have not considered it necessary to make this change since the mirror and tool move at quite different speeds. If they moved at the same speed, astigmatism would, of course, result.

"When roughing out the curve, the machine provides the overhang recommended by Everest in his article in 'Amateur Telescope Making—Advanced.' The stroke and swing should be as long as possible consistent with the avoidance of tipping. The machine should be operated by pulling the belt until the operator is quite sure that the mirror will not tip, before starting the motor.

"As Everest explains, the elliptical-overhang stroke results in the center of the mirror being hogged out, while the edge is scarcely touched. If, therefore, the rough grinding is continued until the center of the mirror is deep enough, the outside zone will be practically flat, giving a shape like the inside of a 'tin hat,' and it will be impossible to bring the curve out to the edge without deepening the center. To avoid this, grinding should be stopped when the center is about two thirds the correct depth, and the stroke and swing gradually shortened. With a little care the right depth can be reached just as the curve reaches the edge.

"The elliptical stroke pushes the abrasive off the edge. For this reason no paper is used on the platform during rough grinding, so that the mess may be scraped off and settled after each spell of grinding. Carborundum and water may be added from time to time as the machine operates, but the disks should be washed off about every 15 minutes. A weight of about 8 ounces per square inch is advised for rough grinding, tapering to 4 ounces for fine grinding and zero in

the last stages of the same process.

"The well-known practice of reversing mirror and tool between each stage of fine grinding is highly recommended as a sure method of bringing the disks to spherical contact. I can also recommend a minor discovery of my own for testing contact. Buy a tube of artists' 'Black Stumping Chalk.' Smear a little of this across a diameter of the clean, dry tool. Lower the mirror centrally into place and rub gently without pressure. When the mirror is removed its surface will show black streaks at all points of contact.

"Much may be done in reducing high zones by smearing abrasive on the zone to be operated on, and using a very short stroke. It should also be remembered that the greatest abrasive action takes place at the points where the edge of the tool comes at the end of a stroke. Repeated changes in the adjustment of the cranks is therefore the secret of avoiding gross zonal errors. This applies even more strongly in polishing.

"Polishing will be done with pitch, pitch with wax facets, or HCF, according to the taste of the operator. Long spells of polishing can be carried out by using HCF combined with rouge and soapy water. As Hindle points out, the use of soap obviates the necessity of scoring the facets. With regard to figuring, in spite of popular belief to the contrary, it is perfectly possible to complete this operation on the machine without any hand work at all.

"Crank shaft *J* rotates at 60 R.P.M. *H* at about 13 R.P.M. and the platform at about 2 R.P.M. These figures are reduced by one half during rough grinding by the use of a smaller pulley on the motor.

"The 12½" Pyrex mirror for the telescope shown in Figure 2 was ground by hand before the machine was built, but polishing and figuring were done on the machine, including the correction of a very bad hyperbola. The mounting of this telescope, which is designed for the University of Alberta, is a modification of the familiar double yoke, with the declination axis off-center to provide greater access to the polar regions. This necessitates a counterweight of about 125 pounds to balance the tube. The head of the tube moves on ball bearings, being turned by a hand-wheel (not seen) engaging with a circular rack.

"The entire telescope weighs about 750 pounds. The foundation and upright are, of course, temporary, as a concrete pier will be provided. The 24" wheel at the top of the polar axis provides means for the installation of a drive designed along the lines of the one invented and described by Mr. H. Boyd Brydon in a recent issue of the *Journal of the Royal Astronomical Society of Canada*. "Dignity and Impudence" are exemplified by the 4" Richest Field Telescope seen in the lower right hand corner of the picture.

"The Hindle machine is a labor-saving rather than a time-saving device. Rough grinding will take as long, possibly longer, than by hand, since we cannot increase the speed much beyond one stroke per second without nullifying the tendency for the upper disk to become concave, and changing abrasive is a slower job than in hand work. Some saving of time may be expected in fine grinding, and there is less temptation to skimp this vitally important item. Polishing is much faster than by hand, principally because long spells of work are possible without interruptions for rest.

"Perhaps the greatest advantage of machine-work lies in its perfect regularity. Despite popular opinion, there is no special virtue, *per se*, in the irregularity of hand polishing. The ideal lies in what may be called 'uniform irregularity.' With the Hindle machine the cranks are adjusted to give any desired stroke and, as long as the machine is running, this stroke is maintained with perfect uniformity, but never twice over the same area of the tool or mirror. The slightly eccentric relation of the disks, the movement of the swing-crank, the rotation of tool and mirror, all combine to give an almost infinitely varied distribution of abrasion within the limits set by the chosen adjustments. Since these adjustments may be changed at will, it will be seen that we have here the mirror-maker's ideal of complete flexibility combined with absolute accuracy."

JOBS. Amateur telescope makers who may think of getting jobs in the industries which now are making optical products for defense may obtain, gratis, from this department, "personal history forms" which, when filled out and returned, will become part of a roster available to these industries.

As a matter of fact, a number of the amateur telescope makers already have been working in such plants, and for some time past, and they have been successful.

One of the early crop of amateur telescope makers was Winston Juengst, whose photograph appears on page 402 of "A.T.M.," a photograph taken years ago when he was a youth. Juengst subsequently completed a full course in optometry at the University of Rochester and now is supervisor of the School of Mechanical Optics, at Montague and Henry Streets, Brooklyn, N. Y. A number of men, starting with little or no optical experience, have passed through this school and on into industry.

Other amateurs are in the game professionally, here and there, and every effort is being made by this department to direct the skills acquired by followers of the hobby into defense work.

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with a list of available titles, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for.

BLUEPRINT READING

By F. D. Graham

IN THIS pocket-size, flexible-binding book the reader is led simply and easily through the fundamentals of blueprint making and reading, the knowledge so imparted giving him a thoroughgoing background for actual work with prints. Included are listings of special notations, abbreviations, and so on used on various types of drawings. (353 pages, 5 by 7 inches, thoroughly illustrated with drawings.)—$2.00 postpaid.—*A. P. P.*

WE NEED VITAMINS

By Walter H. Eddy and G. G. Hawley

COMPACT little pocket primer of the nature and functions of all the known vitamins, for laymen who wish up-to-date scientific data, not too technical, but not shallow. Senior author is professor-emeritus in physiological chemistry at Columbia University and is one of the outstanding research workers on vitamins and foods. (102 pages, 5 by 7½ inches, unillustrated.)—$1.55 postpaid.—*A. G. I.*

ENGINEERING ENCYCLOPEDIA

Edited by Franklin D. Jones

IN condensed form this two-volume set presents essential facts regarding 4500 important engineering subjects. The text is designed particularly for use by engineers, mechanics, technical schools, and public libraries. In addition, these volumes will serve admirably to supplement a general encyclopedia used by anyone whose thirst for accurate knowledge extends into any of the fields of engineering. (Two volumes, uniformly bound, each 6½ by 9 inches, a few line drawings, 1432 pages total.)—$8.10 postpaid for the two volumes.—*A. P. P.*

TOOL DESIGN

By Charles Bradford Cole

LINKING the work of the engineering department with the production job, the tool designer plays an important part in practically all industrial endeavors. His job of selecting the machines and developing the tools that will produce parts with a high degree of accuracy and speed is of outstanding value when he is equipped to do it in the proper manner. In this book, designed as a companion text to "Tool Making" by the same author, the worker who is just starting on the job of tool designing will find valuable information and help on simple jobs; the expert will find many suggestions to help him in the problems which his work presents. Throughout the book stress is laid on practical applications, a feature which reduces theory to a minimum and places practice as the ultimate end. (498 pages, 6 by 9 inches, complete index, appendices of data, 425 illustrations.) — $4.60 postpaid. — *A. P. P.*

OBSERVATIONS OF MARS AND ITS CANALS

By Harold B. Webb

COLLECTION of observations of Mars, with careful drawings, made in 1937 and 1939 by a number of amateur astronomers, including the author, who is well-known in astronomical circles, using telescopes of four to 15-inch aperture (about as much as can be used to advantage on Mars, anyway). Brief, compact discussion of the polar cap, dark spots, light spots, canals, changes, spectrograms, photographs, charts. Written for other observers, this is not a book for the entirely uninitiate. (51 pages, 5 by 8 inches, illustrated.)—$1.60 postpaid. —*A. G. I.*

BOMBS AND BOMBING

By Willy Ley

WHAT every civilian should know about bombs. Fairly technical. (125 pages, 5¼ by 8 inches, lightly illustrated.)—$1.35 postpaid.—*A. G. I.*

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AFTER a short chapter on the underlying principles of metal cutting operations, the reader of these books is taken immediately into actual practice and is shown by text and illustrations precisely how to set up work on all forms of standard machine-shop equipment. The information presented is the next best thing to doing the work along side an experienced me-

chanic; coupled with actual shop practice, these books should enable the reader to advance rapidly in skill. (2 volumes in uniform binding, 6¼ by 9¼ inches, Volume 1—538 pages, Volume 2—552 pages, both thoroughly illustrated with photographs and drawings.)—$6.15 per set postpaid.—*A. P. P.*

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Edited By H. Bennett

THOUSANDS of tested formulas of interest to engineers, chemists, and executives in every important industry are presented in this volume in a form that has been designed particularly for quick reference. Complete details are given with every formula so that no guesswork is involved in arriving at the desired result. The subjects covered range from adhesives and polishes through cosmetics, inks, lubricants, paints, and other surface finishes, to pyrotechnics, rubber, and plastics, soaps and textiles. (676 pages, 6 by 9 inches, unillustrated.)—$6.10 postpaid.—*A. P. P.*

HORTUS SECOND

By L. H. Bailey and Ethel Zoe Bailey

THE authors, foremost authorities in the horticultural world, have compiled with the meticulous thoroughness that characterizes all their work, this latest edition of a standard reference which is by no means a reprint, but a new work which brings up to date the registry of species and botanical varieties now available in the continental United States and Canada. It will, like its predecessor, prove to be an invaluable, concise dictionary and ready reference handbook of general horticulture, of gardening, and of cultivated plants in North America. It is a volume of inestimable assistance to propagators, botanists, gardeners, nurserymen, landscape architects, and to teachers and students. (778 pages, 7¼ by 10¼ inches, illustrations.)—$12.10 postpaid.—*C. F. G-C.*

HOW THINGS WORK

By George Russell Harrison

NOTED physicist, Director of the Research Laboratory at M. I. T., explains light, atoms, aviation, electricity, sound recording, electron microscopes, and many other things in modern science for lads of about 10 up. Lucid. (301 pages, 6 by 9 inches, illustrated.)—$2.85 postpaid. —*A. G. I.*

THE BOYS' BOOK OF MODEL AEROPLANES

By Francis A. Collins

SO RAPIDLY does the hobby of building and flying model airplanes develop that this revised edition is necessary to bring the whole field

completely up-to-date. Much new and advanced information has been added and a large part of the text has been rewritten in the light of latest progress. Stress is placed on the how-to-do-it phase of model building. (262 pages, 5 by 8 inches, a large number of photographs and drawings.)—$2.10 postpaid.—*A. P. P.*

FIFTY THINGS TO MAKE FOR THE HOME

By Julian Starr, Jr.

SIMPLE descriptions and plans for making such things as knife racks, wall cabinets, shelves, blinds, coffee tables, footstools, cold frames, flowerpot holders, toy guns, wheelbarrows, guest trays, knitting bowls. More suitable for the man who is only moderately constructive than for the adept—who might think it a bit elementary. (207 pages, 6 by 8 inches, illustrated.)—$2.10 postpaid.—*A. G. I.*

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By William Arthur Babson

FASCINATINGLY descriptive of a nearly forgotten strip of New Jersey swamp and woodland, bounded by ultra-civilized highways, only a couple of hours from New York City's Times Square, this is a believe-it-or-not story of a retreat in which the author studied nightly peregrinations of many animals, the homes and habits of thousands of ducks. He writes of all he saw with charming wisdom, conveying a complete sense of the wonder-world of nature that exists so close to civilization, yet is so often unseen, unheeded. (261 pages, 5½ by 8½ inches, 24 halftones from photographs; 2 four-color paintings.)—$3.10 postpaid.—*A. D. R., IV.*

LIVES AND DOLLARS

By J. D. Ratcliff

ACCOUNTS of the original scientific research which gave the world vitamin D, vitamin K, vaccines, serums, insulin, smallpox immunity, and many other discoveries; also of industrial research centers such as Lederle, Corning Glass, Eastman Laboratories. A sort of general mixture of research narratives; easy, not very technical, and on the inspirational side. (225 pages, 5¾ by 8½ inches, unillustrated.) — $3.10 postpaid. — *A. G. I.*

CORK AND THE AMERICAN CORK INDUSTRY

By Arthur L. Faubel

AN ACCOUNT of cork and the cork industry, designed for students and the general reader—not a technical treatise on the subject. (152 pages, 6½ by 9¼ inches, a large number of photographs.)—$1.60 postpaid.—*A. P. P.*

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

DEFENSE ON THE RADIO is an eight-page illustrated booklet describing radio programs now available which give regular reports on the progress of industrial output for national defense. Stations are listed and times of broadcasts are given. *National Association of Manufacturers, 14 West 49th Street, New York, New York.—Gratis.*

MANUFACTURE OF RUBBER PRINTING PLATES is a six-page booklet that summarizes the process involved in successful rubber plate making and deals specifically with materials and methods. Of particular interest to all those in the graphic arts field. *B. F. Goodrich Company, Akron, Ohio.—Gratis.*

CARBOLOY GRINDER BULLETIN (GT-135) deals with cemented carbide tool grinders and presents illustrations on adjusting and using these grinders. Complete specifications are also given regarding recommended accessories. *Carboloy Company, Inc., Detroit, Michigan.—Gratis.*

RADIAL, PIVOT, AND SPECIAL BEARINGS IN MINIATURE PRECISION SIZES is an eight page illustrated catalog which describes these tiny bearings, their applications, the types available, and gives technical data on specifications of the various types. The bearings described are said to meet the rigid requirements of government services and are now being used by precision instrument makers and other manufacturers requiring bearings of unusually small sizes. *Miniature Precision Bearings, Keene, New Hampshire.—Gratis.*

THE SPECTROGRAPHIC ANALYSIS OF TIN-LEAD SOLDERS, by D. M. Smith, deals with the determination of aluminum, bismuth, cadmium, copper, and zinc in tin-lead solders, as revealed by their spark spectra. *Battelle Memorial Institute, 505 King Avenue, Columbus, Ohio.—Gratis.*

THE STADIUM, by Myron W. Serby, is a 64-page bound book which presents technical details of stadia design of interest to all architects and engineers. *American Institute of Steel Construction, Inc., 101 Park Avenue, New York, New York.—$1.50.*

RADIOACTIVE EXPLORATION, by R. Burton Rose, M.A., is a 16-page reprint of an address delivered before the Colorado Mining Association. It discusses some of the fundamental phases of radioactivity as well as recent developments in gamma ray detection instruments and detecting technique as applied in geophysical prospecting for petroleum and ore. The use of a new type portable detecting unit for field prospecting for radioactive ores is demonstrated. *R. Burton Rose, M.A., 1255 Cristina Avenue, San Jose, California.—10 cents.*

TEXSTEEL TEXDRIVE SHEAVES is a 12-page bulletin describing steel and cast iron sheaves for Texrope drives from fractional to 25 horsepower. The illustrations show a variety of applications of this particular type of drive and tables give lists of available sizes and various dimensions. A section is also devoted to a description of a new type of V-belt. Request Bulletin B-6047. *Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin.—Gratis.*

JESSOP MAGIC CHISEL STEEL is an eight-page folder describing a silicon-molybdenum bearing cold work steel for use where extreme toughness and resistance to fatigue are required. Information presented includes analysis of the steel, treating methods, physical properties, and typical uses. *Jessop Steel Company, Washington, Pennsylvania.—Gratis.*

RADIO FOTO LOG, edited by Samuel Kaufman, is a 28-page pamphlet presenting a listing of broadcast, short wave, and television stations. Included are feature articles and photographs covering many topical phases of radio programs. Published by *National Union Radio Corporation, Newark, New Jersey.—Available through radio dealers and servicemen.*

FILM SCANNER FOR USE IN TELEVISION TRANSMISSION TESTS, by Axel G. Jensen, is a 19-page monograph which describes the design and construction of a television film scanner primarily intended as a testing tool in designing circuits suitable for television program transmission. *Bell Telephone Laboratories, Inc., 463 West Street, New York, New York.—Limited free distribution.*

LESSONS IN ARC WELDING is an 184-page bound book which presents the fundamentals of arc welding in a series of 60 lessons with 170 illustrations. *Lincoln Electric Company, 12818 Coit Road, Cleveland, Ohio.—50 cents in United States, 75 cents elsewhere.*

HEAT TREATING BY ELECTROTHERMIC-PERMEATION is a technical treatise on the principles employed in a new type of salt bath furnace used in the hardening of certain high-speed steels. Furnaces are described and data are given on capacities, power requirements, and so on, of various types. These furnaces are applicable to virtually any heat-treating process requiring temperatures ranging from 300 to 2500 degrees, Fahrenheit. *Upton Electric Furnace Division, Commerce Pattern Foundry & Machine Company, 7450 Melville at Green, Detroit, Michigan.—Gratis.*

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